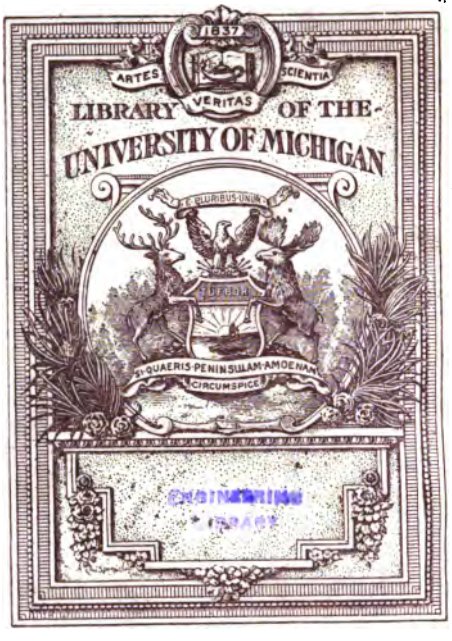
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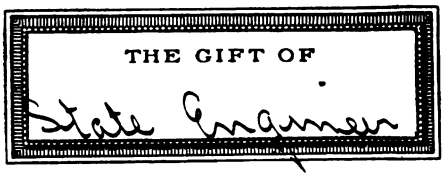
THE GIFT OF
State Engineer

ANNUAL REPORT

OF THE

State Engineer and Surveyor

FOR THE

FISCAL YEAR ENDING SEPT. 30, 1889.

TRANSMITTED TO THE LEGISLATURE MARCH 3, 1890.

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IN ASSEMBLY,

MARCH 3, 1890.

ANNUAL REPORT

OF THE

STATE ENGINEER AND SURVEYOR.

STATE OF NEW YORK:

OFFICE OF THE STATE ENGINEER AND SURVEYOR,
ALBANY, N. Y., *December* 15, 1889.

To the Honorable the Speaker of the Assembly:

SIR.—I have the honor to submit herewith my Annual Report for the fiscal year ending September 30, 1889.

Very respectfully, your obedient servant.

JOHN BOGART,
State Engineer and Surveyor.

REPORT.

OFFICE OF THE STATE ENGINEER AND SURVEYOR,
ALBANY, N. Y., *December* 15, 1889.

To the Honorable the Legislature of the State of New York:

The State Engineer and Surveyor has the honor to submit herewith his report for the fiscal year ending September 30, 1889.

The various divisions of the works which have been under the charge of this Department, are referred to under their respective heads below.

IMPROVEMENT IN SPEED OF TRANSIT BY LENGTHENING THE CANAL LOCKS.

All the locks on the Erie canal are twin locks, that is to say there are two locks side by side, and these two locks were constructed of the same size.

These locks have a length of chamber between the posts, on which the lock gates turn, of one hundred and ten feet. The actual available length, or the maximum length of boat which can pass through these locks is about ninety-eight feet; this length varying slightly with the shape of the hull of the boat.

Since 1886, the length of one of these twin locks has been doubled in twenty-seven cases on the Erie canal, and the lengthening of seven other locks is now under contract, and will be finished at the opening of navigation next spring. Seven locks on the Oswego canal have been lengthened and two others are under contract and in progress.

When a lock is lengthened, the distance between the gate posts is made two hundred and twenty feet, and the available length becomes two hundred and eight feet.

The reason for this lengthening is that the boats on the canal are now largely run in pairs, one steamer of the full size which can pass the locks, pushing a boat of the same size and towing two other boats also of the same size. Many of the boats which are propelled by horses are coupled in the same way, such arrangement reducing the expense considerably. The time occupied by uncoupling the boats at every lock is a serious loss, and the saving by constructing the lengthened locks, so as to take the two boats at once, is decided. When the work in progress is completed this spring, the canal can be used for double headers without uncoupling; on the Erie canal for the total length of 314.21 miles, distributed, however, in four sections at different parts of the canal as follows:

	Locks.	Miles.
Upper Mohawk Aqueduct to Little Falls,	22 to 36,	56.93
Mohawk to Newark	43 to 57,	127.86
Newark to Lockport	59 to 67,	97.42
Lockport to Buffalo	71 to city,	32.00
Total		314.21

The long stretches on the Erie canal available for double-headers, without uncoupling, amounted last season to 299.22 miles. There will thus be an additional length next season of 14.99 miles.

On the Oswego canal there will be next season 30.41 miles available for double-headers, without uncoupling, as follows:

	Locks.	Miles.
Salina to Fulton	3 to 8,	24.06
Fulton to Minetto	8 to 12,	6.35
Total		30.41

The increase on the Oswego over the past season will be 0.69 miles.

It will be seen from the table above that there is a break in the continuity of these stretches on the Erie canal, at

Newark, at which point there are three locks with very short pieces of canal between them. In my report of last year it was suggested that it would be well to substitute two locks for these three. This could be done at the expense of about $300,000, and the result would be an uninterupted stretch of navigation for double-headers of 225.62 miles from Newark to Lockport.

The locks lengthened on the Erie canal are Nos. 27, 28, 29, 30, 31, 32, 33, 34, 35, 44, 45, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 60, 61, 62, 63 and 72, and those under contract are Nos. 23, 24, 25, 26, 46, 65 and 66.

The Legislature in the several acts directing the lengthening of locks committed the designation of the locks to be lengthened to the decision of the Superintendent of Public Works and the State Engineer, with certain statutory provisions as to the divisions of the canals. The selections have been made with regard to securing as long stretches of uninterupted navigation for double-headers as was practicable. It will be noticed that no locks have been lengthened east of No. 23, which is the lock immediately west of Schenectady. If the Legislature directs the continuance of the policy of lengthening one of the twin locks, those eastwardly from No. 23 can be lengthened to No. 18, which is at the head of the chain of sixteen locks at Cohoes. These sixteen locks have a total lift of 163.85 feet. They are not combined locks, but they are built at a very short distance apart, varying from 500 to 1,600 feet. Some portions of the stretches of canal, between these locks, are short curves. To provide for passing double-headers through these locks, without uncoupling, would require a large expenditure. The two locks east of the foot of the Cohoes locks could be lengthened without serious difficulty.

The next present break in the continuity of the lengthened locks is at locks Nos. 36 to 43 inclusive, a distance of but 9.54 miles. The stretches between these seven locks are therefore very short, and while it would be doubtless a saving in time of transportation that these locks should be lengthened, yet the loss is much less than where the dis-

tances between locks are greater. There are also special difficulties connected with the lengthening of the locks at Little Falls, Nos. 37, 38 and 39, which would cause greater expense than has been the case at the locks already lengthened.

The next break is at the three locks at Newark, Nos. 57, 58 and 59. The subject of the best method of securing lengthened locks at this point, has been referred to above. The work could be advantageously done as there suggested, and if done will remove the one break in the continuity for double-headers of 225.62 miles of canal.*

The next break in the stretch of canal navigable for double-headers is at lock sixty-seven, which is the lower lock of the five combined locks at Lockport. These five locks have each a lift of eleven feet two inches, thus giving a total lift of fifty-five feet ten inches. It will be practicable to provide for the passage of double-headers either by a reconstruction of the locks, making some of them double the present lift, in which case much of the present masonry could be made use of, or a hydraulic lift might be constructed, as has been already done at points in Europe.

From the head of these combined locks the passage for double-headers is now unrestricted to Lake Erie.

On the Oswego canal the locks already lengthened are guard locks Nos. 1, 3 and 4, and locks Nos. 5, 6, 7 and 11. The locks Nos. 9 and 10 are under contract and will be finished for the next season; there remain eleven ordinary and two guard locks. The lengthening of lock No. 8 at Fulton, would connect the stretches of canal having long locks, so that there would be 30.41 miles to be used by double-headers without uncoupling. The locks on the Oswego, which connect short river levels where there are strong currents, do not so much require lengthening, because double-headers can with difficulty be run on those levels.

*Since writing this report, complications have arisen as to the contract for the lengthening of lock No. 46, and it seems probable that this lock will not be lengthened at present.

MACHINERY.

The machinery for drawing ascending boats into locks has been improved by the substitution of iron frames in place of old timber frames. These are neat and strong and work very satisfactorily, and are used with great saving in time both in hauling in boats and starting them out. Wire cables were tried with machinery but have not proved satisfactory, as they are heavy to overhaul and wear very rapidly so that they break easily.

WATER REQUIRED FOR LOCKAGES.

Experiments were made some time since under the direction of the Superintendent of Public Works, with regard to the advantage to be gained in facilitating the speed of navigation by aiding the entry of boats into the locks and their passage out by opening one or more of the paddle valves in the gates, thus drawing a boat into the lock and flushing it out more speedily than can otherwise be accomplished. The result of these experiments is given below and the Deputy State Engineer, Mr. A. S. C. Wurtele, has made the following estimate of water required for lockages.

Lock 28.—7.72 lift—One head paddle 99.28 cubic feet per second. One foot paddle 115.31 cubic feet per second,

Lock 30.—10.21 lift—One head paddle 118.06 cubic feet per second. One foot paddle 134.18 cubic feet per second.

Time to empty lock 28, 1 m. 55 s. Lock 30, 2 m. 40 s.

	Entering.		Leaving.		Total time.				
	M.	S.	M.	S.	M.	S.			
Lock 28.....	2	40	2	30	7	5	1 pad. in, 18,449;	1 pad. out, 14,892	= 33,341.
	2	25	2	40	7	0	1 pad. in, 16,720;	2 pad. out, 31,771	= 48,491.
	2	25	2	39	6	59	1½ pad. in, 25,080;	3 pad. out, 47,355	= 72,435.
	2	00	2	25	6	20	1½ pad. in, 20,754;	3 pad. out, 43,188	= 63,942.
	1	59	2	50	6	44	1½ pad. in, 20,585;	2 pad. out, 33,756	= 54,341.
Lock 30.....	3	40	4	18	10	33	1 pad. in, 29,519:	1 pad. out, 30,459	= 59,978.
	3	35	4	00	10	15	1 pad. in, 28,848;	2 pad. out, 56,668	= 85,516.
	3	30	2	44	8	54	1 pad. in, 28,078;	3 pad. out, 58,086	= 86,164.
	2	00	3	44	8	24	1 pad. in, 16,102;	3 pad. out, 79,335	= 95,437.
	1	45	1	47	6	12	1½ pad. in, 21,132;	2 pad. out, 25,262	= 46,394.
	2	50	2	10	7	40	1½ pad. in, 34,215;	3 pad. out, 46,041	= 80,256.
	2	45	2	45	8	10	1½ pad. in, 33,210;	3 pad. out, 58,440	= 91,650.

It was found that in drawing in boats only one paddle could be used advantageously, as with more than one the

boat is liable to damage the gates and coping. In swelling out, the gain in time with three paddles used is very slight over two paddles, so it is considered most advantageous to use one paddle for drawing in and two paddles for swelling out, with an average result as follows:

Lock 28.—Time of lockage 7 minutes, 12 seconds; water drawing in, 17.527 cubic feet; water swelling out, 32.763 cubic feet. Total, 50.240 cubic feet.

Lock 30.—Time of lockage 8 minutes, 45 seconds; water drawing in, 25.628 cubic feet; water swelling out, 41.085 cubic feet. Total, 66.713 cubic feet.

Time without use of water, twenty-seven minutes; showing a gain of about twenty minutes per lock or twenty-four hours between Albany and Buffalo, there being seventy-two locks to be passed.

In drawing water through paddles the velocity is proportional to the square root of lift, and the velocity in chamber proportional to the relative area of the paddles used and the chamber, and the velocity of the boat will be inversely to above proportions, therefore the time of entry will be the same for all lifts, but the time of leaving will vary.

The average time of drawing in with one paddle is two minutes, fifty-two seconds, and the average time of swelling out with two paddles is two minutes, fifty seconds, as given by experiments. Taking this for an average lift of nine feet, (experiments not being sufficient to make exact figures) and considering the time of emptying lock as being proportional to the square root of the lift, the following times result:

LIFT.	Entry.		Empty.		Leaving.		Total time.	
	Min.	sec.	Min.	sec.	Min.	sec.	Min.	sec.
Eleven feet	2	52	2	32	2	34	7	58
Ten feet	2	52	2	26	2	42	8	00
Nine feet	2	52	2	18	2	50	8	00
Eight feet	2	52	2	10	3	00	8	02
Seven feet	2	52	2	02	3	12	8	06
Six feet	2	52	1	53	3	25	8	10
Five feet	2	52	1	42	3	38	8	12

The above gives for water used in one lockage.

LIFT.	Time of lockage.	Lock capacity.	Drawing in.	Swelling out.	Total water.
	Min. sec.				
Eleven feet	7 58	47,161	23,950	37,730	108,841
Ten feet	8 00	42,874	22,795	37,778	103,557
Nine feet	8 00	18,597	21,641	37,638	97,876
Eight feet	8 02	34,122	20,414	37,579	92,115
Seven feet	8 06	29,857	19,188	37,550	86,598
Six feet	8 10	25,528	17,674	37,066	80,265
Five feet	8 12	21,271	16,157	36,037	73,465

GATE LEAKAGE.

In 1848 gate leakage was measured as follows:

	Cubic feet per minute.
At Lock 60, 10 feet lift	1,344
At Lock 61, 8 feet lift	1,220
At Lock 47, 10 feet lift	1,000
At Lock 50, 8 feet lift	900
At Lock 51, 5.6 feet lift	800
At Lock 52, 11.4 feet lift	1,050

These figures show a fair approximation to the proportions of the square root of the lift, as it should be, the conditions being the same.

Adopting the average of 1,172 cubic feet per minute, for ten feet lift, the water used in gate leakage would be:

	Cubic feet per minute.
Lift 11 feet, gate leakage	1,231
Lift 10 feet, gate leakage	1,172
Lift 9 feet, gate leakage	1,113
Lift 8 feet, gate leakage	1,055
Lift 7 feet, gate leakage	984
Lift 6 feet, gate leakage	908
Lift 5 feet, gate leakage	832

TURBINES.

The introduction of machinery to haul ascending boats into the locks is a very great advantage; indeed, without this machinery it is difficult to get a double-header into a lock. This machinery is run by a turbine wheel set in the well at head of lock and discharging through the cul-

vert under the center pier wall. Spools are provided for cable for hauling the boats. There is also a friction break. The water used by these turbines is as follows:

LIFT.	TURBINE.		Water per second.	Water in ten minutes.	Horse power.
	Diameter.	Depth of bucket.			
	Inches.	Inches.	Cubic ft.	Cubic ft.	
Eleven feet	22	6	9.45	5,670	9.41
Ten feet	22	6	9.01	5,406	8.18
Nine feet	22	6	8.54	5,124	6.98
Eight feet	28	7	11.93	7,158	8.66
Seven feet	28	7	11.18	6,708	7.24
Six feet	28	11	16.23	9,738	8.82
Five feet	28	11	14.81	8,886	6.72

In 1888, the time of passing lock 54 with use of machinery was nine minutes and forty seconds; lock 56, ten minutes.

LOCKAGES.

From table in Canal Auditors report on trade and tonnage, the greatest average daily lockages for one month is deduced.

One month in year	1824.	1825.	1826.	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.
Daily average	34	60	84	87	64	71	82	89	103	104	118
One month in year	1835.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.
Daily average	141	136	126	158	111	138	161	153	138	146	156
One month in year	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1953.	1854.	1855.	1856.
Daily average	163	229	202	200	208	201	201	218	195	169	169
One month in year	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.
Daily average	144	133	126	213	198	179	203	175	149	171	197
Greatest one day	....	....	303	270	...	....	....	....	....	....	259
One month in year	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.
Daily average	182	165	144	168	185	176	121	117	100	146	178
One month in year	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	.....
Daily average	166	152	....	....	....	....	97	....	112	.....	.....

The greatest number of lockages in one day is 303, and the greatest daily average for one month is shown often to have gone over 200, so that in calculations for use of water a daily lockage of 240 for one pair of double locks is not a high rate; this would give one lockage in every twelve minutes for such lock.

On this basis with foregoing quantities as calculated for capacity, swelling, gate leakage and turbine, the water required for lockages alone through one lengthened lock is as follows in cubic feet per minute:

LIFT.	Lock, cubic feet.	Drawing and swelling, cubic feet.	Gate leakage, cubic feet.	Turbine, cubic feet.	Total cubic feet. Minutes.
Eleven feet	1,970	2,570	1,231	236	6,107
Ten feet	1,786	2,524	1,172	225	5,707
Nine feet	1,608	2,465	1,113	214	5,400
Eight feet	1,422	2,416	1,055	298	5,191
Seven feet	1,244	2,364	984	280	4,862
Six feet	1,064	2,281	908	406	4,659
Five feet	886	2,175	832	370	4,263

EVAPORATION AND FILTRATION.

Evaporation from water surface was carefully measured by Professor Coffin at Ogdensburg, in 1838.

MONTH.	Monthly in.	Daily in.	MONTH.	Monthly in.	Daily in.
January	1.625	0.0533	August	5.415	0.1745
February	.817	0.0292	September	7.400	0.2466
March	2.067	0.0667	October	3.948	0.1273
April	1.625	0.0542	November	3.659	0.1220
May	7.100	0.2290	December	1.146	0.0370
June	6.745	0.2248			
July	7.788	0.2512		49.335	

Daily average, 0.2252 May to September in.

In Canal Commissioners Report for 1866, evaporation is given:

	Inches.
Measurements in St. Lawrence county (daily for dry season).	0.33
Measurements in Central park, N. Y., (daily for dry season).	0.50
J. Tremper, Seneca lake (daily for dry season)	0.40
Chemung canal (daily for dry season)	0.20
Professor Coffin, Ogdensburg — above (daily for dry season),	0.23
Average	0.33⅓

Taking this average of 0.33⅓ inches daily evaporation for dry season, will give per mile of canal, as enlarged, to seventy feet of water surface, 7.13 cubic feet per minute.

FILTRATION.

In 1847 Mr. O. W. Childs reported the loss from filtration, evaporation and leakage on Palmyra level in July, from measurements, at 84.05 cubic feet per mile a minute on the old canal, and between Pittsford and Lockport, as measured by Mr. Bennett daily between the seventeenth of July and the thirtieth of September, at 73. cubic feet per mile a minute. The old canal was forty feet wide at water surface, and four feet deep and twenty-eight feet bottom, giving 42.5 wet perimeter. The enlarged canal is seventy feet wide at water surface, seven feet deep, and 52.5 feet at bottom, giving seventy-five feet wet perimeter. Filtration is proportioned to wet perimeter, and also to depths; not square root of depth as generally given, because the filtration will depend on the pressure and not on velocity.

The evaporation on the old canal forty feet water surface is 4.08 per minute per mile.

Taking average of 84.05 and 73.00–78.53, deducting evaporation 4.08, gives 74.45 cubic feet mile minute for filtration and leakage on old canal, and deducing proportions above mentioned, $\frac{75}{42.5} = 1.76$ and $\frac{7}{4} = 1.75$, therefore filtration and leakage on enlarged canal will be 74.45x1.76x175=229.3 cubic feet per mile minute, and this agrees well with later reports on loss of water; adding 7.2 for evaporation on enlarged canal gives 236.5 cubic feet mile minute for total loss.

LIFT BRIDGES.

The lift bridges constructed by the State over the canals and now in use are:

1 Broad street, Waterford (Champ.), cylinder power..... 1889
2 Railroad street, Mechanicville (Champ.), hand power.... 1887
3 North Ferry street, Albany (Erie), cylinder power 1889
4 Main street, Fort Plain (Erie), turbine power..... 1888
5 John street, Utica (Erie), cylinder power..... 1888

6 Hotel street, Utica (Erie), hand power..... 1874
7 West street, Syracuse (Erie), cylinder power..... 1888
8 Glasgow street, Clyde (Erie), hand power 1888
9 West Main street, Rochester (Erie), cylinder power..... 1889
10 Main street, Brockport (Erie), hand power..... 1888

Plans are being prepared for two others,

11 Geneva street, Lyons.
12 Caledonia street, Rochester.

A number of other lift bridges are in operation over the canal not built by the State, but by the local authorities.

An act was passed by the Legislature for the construction of a lift bridge at Schuyler street, Utica. It was found, however, that its construction at that point would so interfere with the working of lock No. 46, that it has not been built; the extension of lock 46 at its head, bringing the chamber of the lock directly under the site of the proposed bridge. It would be impossible to work the canal with a bridge down on the coping of the lock. The Division Engineer of the middle division has suggested the construction of a swing bridge above the lock and a foot bridge in the line of Schuyler street, which might solve the difficulty, but which will require legislative action authorizing a swing instead of a lift bridge.

The Clyde and Brockport lift bridges are to be changed from hand power to water power by the introduction of turbines.

When a request is made for a lift bridge to replace an existing bridge in good condition, it is a question whether the cost of such a change should not be a charge to the locality rather than to the taxpayers of the whole State. Some of the changes desired are really unnecessary, and in cases are asked only so as to improve the appearance of a village street.

The cost to a village of the constant pay during the season of navigation of the men required to open and close these structures represents the interest on a considerable capital, and is a serious item in the local tax.

TOWPATHS.

Double-headers now being the rule on the Erie canal, and as they are towed by a triple team, it was found necessary to widen the towpath. It was decided by the Superintendent of Public Works and the State Engineer that all new structures should be set back so as to leave a clear towpath eighteen feet wide, that being the least width in which two triple teams can pass. The standard width of towpath is now fixed at eighteen feet on the Erie canal.

NAVIGATION OF THE CANALS.

The canals were officially opened on the first day of May, 1889, and closed on the first day of December, 1889.

The unusual number of seven breaks on the Erie, and one on the Black River canal, occurred during the past season. These were to some extent due to an unusually wet spring, not allowing the banks to dry out. The total delay to navigation was eighteen days. The breaks were as follows:

November 19, 1888, on the Black River canal, the towpath was washed out for a length of thirty-six feet to canal bottom. The break was repaired by filling in 600 cubic yards of material. The delay to boats was three days.

March 30, 1889, Erie canal, at Fish creek, two and one-half miles east of Medina, the north end of a twelve-foot double arch culvert under the canal gave way, the tow-path was washed out sixty feet to about twelve feet below canal bottom, the bottom of canal was also washed down twelve feet, forty feet wide and for a length of 400 feet. The west abutment had to be rebuilt a length of ninety-two feet and the center pier fifty feet, also the arches of the same lengths. The abutment is founded on rock, except thirty feet at the north end, which is on quicksand, and was put in with a double timber platform, sheet piled and concreted. The repairs took 450 cubic yards of masonry, 100 cubic yards of concrete, 100 cubic yards of puddle, 9,000 cubic yards filling, and 100 lineal feet sheet piling. They were completed in twenty-four days, in time to open the canal on the day fixed.

May 12, 1889, Erie canal, at a culvert two miles east of Clyde, water forced up the bottom of the culvert at its north end, and for a length of twenty-five feet. This is a triple composite culvert without sheet piling and standing on piles. It was necessary to sheet pile both sides of the culvert, fill the space between the piles with stones and grout the whole, besides concreting the top. This work required 600 cubic yards excavation, 500 cubic yards filling, 200 cubic yards puddle, 100 cubic yards loose stone, fifty cubic yards concrete, and 150 lineal feet sheet piling, and navigation was interrupted for six days.

June, 20, 1889, at lock No. 60 (Macedon), Erie canal, the bottom of the old lock washed out near the head, and the center pier settled eight inches for a length of sixteen feet. This was repaired by underpinning, filling with stones and grouting. The delay to navigation was three days.

June 24, 1889, Erie canal, at Fort Hunter, 600 feet west of lock No. 30, the outside of the high berme bank slid off, and a serious break was prevented by loading the toe of the bank and filling up the slide. The delay to navigation was one day.

July 20, 1889, Erie canal at Fort Plain. The end of one pier of Otsquago creek aqueduct was torn off during a freshet, letting two panels of the aqueduct fall out. This was repaired by a timber platform and bents braced on the platform to replace the pier. The delay to navigation was two days.

August 26, 1889, Erie canal at Shelby Basin, three miles west of Medina. The berme bank washed out sixty feet long, fifteen feet below canal bottom. Repaired by clay filling and sheet piling. It required 2,000 cubic yards, sixty feet in length of good clay bank. The break was probably occasioned by a rat hole. The delay to navigation was four days.

September 20, 1889, Erie canal at Van Wie's aqueduct three miles west of Fultonville. A loaded boat struck the side of the aqueduct and knocked out one panel. It was

repaired by placing timber across the panel. The delay to navigation was two days.

HUDSON RIVER IMPROVEMENT.

Under chapter 106, of the Laws of 1889, the improvement of the channel of the Hudson river between Troy and Coxsackie has been continued.

In the last report of the State Engineer; in the report of the assistant engineer in charge of the Hudson river work accompanying it; and also in the report made by the finance committee of the Senate on February 5, 1889, attention has been called to the condition of the works undertaken years ago by the United States government on this river. These works are in very bad repair; they certainly should be put in good repair, and it would seem that, considering the enormous commerce passing through this river, the United States government ought to prosecute the works requisite for the maintenance and improvement of its navigation. Large sums of money are spent annually for the improvement of navigation on rivers in other States, while on this great channel of communication nothing worthy of mention has been done for years. Unless Congress should direct vigorous action immediately, it certainly will be necessary for the State of New York to continue to do more or less work during the next season in order to insure free navigation in that part of the river between Troy and Coxsackie, which is now liable to be obstructed by the formation of bars in the spring. Should the United States government inaugurate measures for improvement of the channel of the river, it will be advisable that the State should arrange for a sufficient expenditure to remove such bars next spring, as there is no probability that the work undertaken for a permanent improvement by the general government will then be effective.

In the report of the assistant engineer in charge of this work, which accompanies this report, detailed information is given in regard to it. Particular attention is called to his recommendation for the establishment of a pier and bulk-

head line for the Hudson between Troy and the city of Hudson.

ALBANY BASIN.

Dredging has been carried on in the Albany basin, but the sewerage of Albany is again filling it up with material of a very unwholesome character. Only a radical treatment will result in a permanent improvement. The sewerage of the city of Albany should by some means be carried to a point below the basin. An intercepting sewer should be constructed, and it probably would be desirable for a portion of the length of the basin to build a wall with the intercepting sewer between it and the present dock. This space could be filled in, thus making available land for commercial purposes.

THE CHAMPLAIN CANAL.

The improvements carried on last winter have been of great benefit to boatmen who call the improved stretches of canal, paradise. These improvements should be continued till the whole canal is of the enlarged size of six feet depth, fifty-six feet width on water surface, and forty-four feet width on bottom.

The importance of the Champlain canal is shown by the tonnage of 1,168,304 tons carried in 1888, and which is fast increasing.

The improvements completed are as follows:

	Miles.
Champlain canal, 1885	2.62
Champlain canal, 1888	2.61
Champlain canal, 1889	3.11
Total	8.34
Under contract	5.41
Total	13.75
Glens Falls feeder, 1885	0.32
Glens Falls feeder, 1888	0.06
Glens Falls feeder, 1889	0.43
Total	0.81

A considerable appropriation could be advantageously expended on this canal so as to give the full value to former improvements by uniting detached pieces of work.

The most important work now demanding consideration is the enlargement of the canal through Mechanicville, improving sharp curves south of Fort Ann, and rebuilding lock No. 16 at Fort Ann, which has settled badly and should receive early attention.

THE BLACK RIVER CANAL.

This canal is of great value to the northern parts of the State. A large lumber business is transacted which is made possible only by this water transportation. There are considerable manufacturing interests growing up in Lewis and Jefferson counties which depend much upon the Black River canal. The canal, therefore, should not be allowed to fall into decay as it certainly will, if the small amount of $16,000 yearly is all that is appropriated as heretofore for rebuilding locks.

Between Rome and Boonville there are seventy locks of which four have been rebuilt by the Superintendent of Public Works and three by contract under appropriations; one is also under contract to be rebuilt this winter. Many of the remaining sixty-two locks are giving away on account of poor stone and bad foundations. Locks Nos. 1, 11, 36, 46, 49, 50, 55, 59 and 61 require rebuilding at once. This work would cost about $160,000 and would be a good investment for the State, if the canal is to be kept open. The increased cost of maintenance under existing laws renders it impossible for the Superintendent of Public Works to do any of the above work with the ordinary appropriations.

Between Boonville and Lyons Falls there are thirty-nine locks which are built of good stone from Sugar river quarries and are in good repair, except lock No. 76 which has settled about eight inches at the head and will shortly require rebuilding.

THE CAYUGA AND SENECA CANAL.

The piers and docking at Seneca and the piers at Ithaca have been repaired and lock No. 8 is now under contract for rebuilding. Plan and estimate is being made for repairs to wall and canal bottom at Seneca Falls. The Bear Race work at Waterloo is still stopped by injunction.

THE CHEMUNG CANAL.

Havana Basin is now under contract and the swing bridge at Watkins is being built. Contractors have been badly delayed by high water in Seneca lake. There can be no expectation of much business use of this canal.

THE GENESEE RIVER.

The following resolution was passed by the Senate at the last session:

WHEREAS, The State Engineer and Surveyor in his last report to the Legislature states that in case of any serious accident to the Erie canal west of Rochester the supply of water from the Genesee river immediately available would be of great value; and,

WHEREAS, It is alleged that one cause in the delay in navigation on the Erie canal after the break in said canal in July last was repaired, was owing to the decrease of the water supplied by the Genesee river feeder, and that reservoirs constructed near the route of the abandoned Genesee valley canal and near that portion which was retained by the State for canal purposes are now of no value in increasing the flow of water into the Erie canal, but with a reasonable expenditure of money can be utilized to the great advantage of the State; and,

WHEREAS, It is alleged that the interests of the State and the usefulness of the said canal can be enhanced by artificial means for storing water in the Genesee river during the flood months, and that the natural decrease yearly in the flow of water in the said river can be counteracted in that way; therefore,

Resolved, That the State Engineer and Surveyor be and he hereby is directed to investigate the allegations above recited and matters pertaining thereto, by gathering data, facts and information relating to the same, by a personal examination of

the territory embraced in the water supply of the Genesee river feeder, the reservoirs above referred to, their inlets and outlets, and that portion of the Genesee valley canal reserved and above referred to, by referring to the records of the canal board and other records and in such other ways as he shall deem expedient and advisable, inform himself, and report to the Senate whether the interest of the State will be subserved by making repairs to the reservoirs above referred to, the inlets, and outlets thereof and that portion of the Genesee valley canal reserved by the State, and by the construction of reservoirs or a dam or dams in the Genesee river for the storage of water during the flood months, accompanied by such suggestions as he may deem proper.

In order to secure the information required by this resolution, a survey has been made of a portion of the valley of the Genesee where the high banks on each side of the river give an apparently favorable opporunity for the construction of a storage reservoir of remarkably large capacity. This survey has been finished, the country forming the water-shed of the river has been generally examined and a special report will be presented on the subject.

SURVEYS FOR THE COMMISSIONERS OF THE NIAGARA FALLS RESERVATION.

The Legislature authorized these surveys to be made by the State Engineer. They are now in progress and will be used by that commission. As they are not yet complete, a detailed reference to them is postponed to a future report.

STATE LANDS.

The duties connected with the matters referred to this department by the Commissioners of the Land Office require constant care and attention both of the State Engineer and Surveyor and of the engineer in immediate charge under his direction of those matters during the year.

Fifty-nine applications for grants of land under water have been considered, eighteen of these being for purposes

of commerce and forty-one for what is technically termed beneficial enjoyment. In the case of eleven of these applications remonstrances were presented and hearings have been had.

Twenty-seven sales of State lands have been made by the State Engineer and Surveyor, realizing $18,266.70.

In a number of cases questions presented to this department in regard to boundaries have been considered and suitable action taken.

THE USE OF WATER FROM SKANEATELES LAKE.

Under chapter 291, of the Laws of 1889, the Syracuse water board applied for the consent of the Canal Board to the use of water from Skaneateles lake. After protracted hearings, the consent applied for was not given. The State Engineer and Surveyor made a report to the Canal Board on questions submitted to him by the board in connection with this subject.

NEW YORK STATE CANALS, 1890.

Length and depth of canals, size and capacity of boats, total tonnage season of 1889.

CANAL.	Length.	Number and size of locks.		Total lockage.	Depth.	Maximum size and tonnage of boats.	Total tonnage, tons.	Mile. Tons.
	Miles.	No.	Length. Width.	Feet.	Feet.			
Erie	351.8	72	110 × 18	655	7	98 ×17.5—6′ draft, 240 tons...	3,673,554	10,442
Champlain	66.0	23	110 × 18	175	*5	98 ×17.5—4.2 draft, 120 tons...	1,187,038	17,986
Glens Falls Feeder	12.0	14	100 × 15	132	4	88 ×14.4—3.5 draft, 85 tons...	.....	.....
Oswego	38.0	18	110 × 18	155	7	98 ×17.5—6 draft, 240 tons...	170,078	4,476
Cayuga and Seneca	23.0	11	110 × 18	83	7	98 ×17.5—6 draft, 240 tons...	196,138	8,528
Black River	35.0	109	90 × 15	1,082	4	78.6×14.5—3.5 draft, 76 tons...	143,561	4,102
Black River Feeder	12.0	1	90 × 15	2	4	.....	.....	.....
Black River Improvement	43.0	2	160 × 30	9	4	142 × 29 — 3.5 draft.....	.....	.....
Black River Delta Feeder	1.4	1	90 × 15	3	4	.....	.....	.....
Baldwinsville	5.8	2	90 × 15	8	4	78.6×14.5—3.5 draft, 76 tons...	.....	.....
Oneida River	20.0	2	120 × 30	8	4.5	102 × 29 — 4′	.....	.....
	608.0			2,312			5,370,369	

* Depth being increased to six feet.

OFFICE.

The maps and plans filed in this department have during the year been indexed.

The number of maps referring to the eastern division is...	219
The number of plans referring to the eastern division is...	132
The number of maps referring to the middle division is....	252
The number of plans referring to the middle division is...	78
The number of maps referring to the western division is...	195
The number of plans referring to the western division is...	154
The number of miscellaneous.....	124
Total number filed	1,154

Also fifty-eight books of plans of enlargement of the canals.

The railroad maps are now being indexed and numbered, which will complete the indexing, which had become absolutely necessary for proper reference.

Record books have been opened for estimates, for final accounts and for documents filed, greatly adding to the convenience and facility of the business of the office. A book of appointments has also been opened and a commission prepared on which the seal of the office is fixed and which is formally issued on each appointment to the engineering staff.

The final accounts during fiscal year ending 30th September, 1889, passed in this office, have been:

ERIE LOCK LENGTHENING.

	Final.	Bid.
1. Lock 27	$25,270 63	$24,356 00
2. Lock 28	25,636 02	26,595 00
3. Lock 29	24,100 14	24,529 00
4. Lock 30	34,172 81	32,851 65
5. Lock 63	23,497 69	23,655 00
6. Lock 64	22,855 41	24,971 50
7. Machinery, locks 27, 28, 29, 30, 63 and 64.....	6,600 00	6,600 00
	$162,132 70	$163,558 15

OSWEGO LOCK LENGTHENING.

	Final.	Bid.
8. Guard lock 3	$19,970 07	$19 086 25
9. Lock 11	29,039 32	30,637 25
10. Machinery, lock 11	2,433 24	2,655 77
	$51,442 63	$52,379 27

BLACK RIVER LOCK.—REBUILDING.

	Final.	Bid.
11. Lock 60	$15,533 85	$13,891 50

BRIDGES.

	Final.	Bid.
12. Bridge street, Albany, substructure	$1,553 27	$1,354 75
13. Bridge street, Albany, superstructure	3,125 00	2,975 00
14. North Ferry street, Albany, substructure	2,786 40	2,116 20
15. North Ferry street, Albany, superstructure	9,834 29	9,375 00
16. Ship street, Cohoes, superstructure	1,893 00	1,868 00
17. Ferry street, Sandy Hill	1,888 51	1,863 80
18. Broad street, Waterford, superstructure	6,776 00	6,600 00
19. Broad street, Waterford, substructure	2,099 49	1,966 75
20. Litchfield street, Frankfort, superstructure	2,474 00	2,394 00
21. York Mills, Whitesboro, superstructure	3,584 97	3,584 97
22. Buffalo street, Ithaca, superstructure	2,469 00	2,469 00
23. Buffalo street, Ithaca, substructure	2,150 76	2,245 50
24. Liberty street, Penn Yan, superstructure	2,000 00	2,000 00

	Final.	Bid.
25. West Main street, Rochester, superstructure	$21,791 53	$20,960 00
26. West Main street, Rochester, substructure	9,610 64	8,378 20
27. Cottage street, Lockport, superstructure	2,662 00	2,662 00
28. Austin street, Buffalo, substructure	4,039 97	4,224 00
	$80,738 83	$77,037 17

CANAL IMPROVEMENT.

29. Champlain canal No. 1, 1888	$2,700 00	$2,334 00
30. Champlain canal No. 2, 1888	19,517 98	19,977 50
31. Champlain canal No. 3, 1888	4,426 91	3,903 25
32. Champlain canal No. 4, 1888	6,212 46	6,978 00
33. Champlain canal No. 5, 1888	2,040 42	1,575 00
34. Champlain canal No. 6, 1888	11,898 59	12,894 50
35. Champlain canal No. 7, 1888	3,944 28	4,585 00
36. Champlain canal No. 8, 1888	5,358 69	5,185 50
37. Champlain canal No. 9, 1888	1,274 89	1,240 00
38. Champlain canal No. 10, 1888	1,800 13	1,770 00
39. Glens Falls feeder, No. 12, 1888	8,420 06	5,430 00
40. Cayuga and Seneca canal at Ithaca	2,438 38	1,970 00
41. Cayuga and Seneca canal at Geneva	4,991,96	3,118 50
	$75,021 78	$70,961 25

MISCELLANEOUS.

42. Crooked lake outlet, 1887	$17,717 74	$17,680 00
43. Crooked lake outlet, 1888	11,702 79	11,550 00
44. Revet. wall, Whitesboro street, Rome	2,803 17	2,986 00
45. Revet. wall, Lock street, Rome	1,144 02	1,046 00
46. Slope wall, Corning	9,968 40	9,965 40
47. Mill creek, Schenectady	9,000 00	9,000 00
48. Prison gate, Clinton	514 21	514 21

	Final.	Bid.
49. Oak Orchard creek, Medina	$11,739 50	$22,300 00
50. Pipe culvert, Ninth street, Rochester	2,363 85	2,807 46
51. Chautauqua lake outlet	25,509 55	22,936 41
52. Albany basin	34,727 87	33,950 00
	$127,188 60	$134,735 98

WORK OF 1888 NOT YET FINAL.

	Bid.
Canandaigua harbor, 1888	$14,135 00
Lock 46, Erie	20,419 60
Ship street, Cohoes, substructure	5,754 60
Glens Falls feeder, No. 11	22,794 50
Bear race, Waterloo	12,875 00
Watkins swing bridge, substructure	4,236 00
Watkins swing bridge, superstructure	2,893 00
	$68,970 70

RECAPITULATION.

	Finals.	Bid.
Finals on Erie locks	$162,132 70	$163,558 15
Finals on Oswego locks	51,442 63	52,379 27
Finals on Black river locks	15,533 85	13,891 50
Finals on bridges	80,738 83	77,037 17
Finals on canal improvements	75,021 78	70,960 25
Finals on miscellaneous	127,188 10	134,735 98
Not yet final	.....	68,970 70
	$512,057 89	$581,538 02

NEW WORK.

Work under Laws of 1889, on which surveys, plans and estimates have been made.

1. Lock 23, Erie, let on bid	$31,561 40
2. Lock 24, Erie, let on bid	29,494 75
3. Lock 25, Erie, let on bid	33,267 50
4. Lock 26, Erie, let on bid	31,130 00
5. Lock 65, Erie, let on bid	27,169 00

6. Lock 66, Erie, let on bid	$25,276 00
7. Lock 9, Oswego, let on bid	24,242 00
8. Lock 10, Oswego, let on bid	23,855 00
9. Lock 12, Black River, let on bid	15,509 90
10. Lock 8, Cayuga and Seneca, let on bid	12,937 30
11. Canal wall at Ilion, let on bid	10,439 50
12. Canal wall at Oswego, let on bid	6,648 00
13. Canal wall at Utica, let on bid	2,391 00
14. Canal wall at Whitehall, let on bid	15,736 50
15. Culver street bridge, Rochester, substructure, let on bid	10,020 55
16. Culver street bridge, Rochester, superstructure, let on bid	4,178 00
17. Prospect street bridge, Lockport, substructure, let on bid	1,283 00
18. Prospect street bridge, Lockport, superstructure, let on bid	2,026 00
19. Liberty street bridge, Schenectady, superstructure and substructure, let on bid	3,525 59
20. Albany basin, dredging, let on bid	2,193 00
21. Forestport dam	48,847 50
22. Clyde bridge, water power, let on bid	1,393 80
23. Brockport lift-bridge, water power, let on bid	2,021 30
24. Havana basin, let on bid	10,293 00
25. Canal wall at Schenectady, let on bid	13,580 36
26. Hudson river, dredging, Coeymans, let on bid	905 63
27. Hudson river, dredging, Nine-mile Tree, let on bid	600 00
28. Hudson river, dredging, repairing pier, Mull's Light, let on bid	1,038 30
29. Hudson river, dredging, Castleton, let on bid	1,016 00
30. Hudson river, dredging, New Baltimore, let on bid	3,623 93
31. Canandaigua harbor, 1889, let on bid	18,873 00
32. Sluice at five combined locks, Glens Falls feeder,	3,154 00
33. Champlain improvement, No. 1, let on bid	31,101 75
34. Champlain improvement, No. 2, let on bid	25,246 00
35. Champlain improvement, No. 3, let on bid	17,640 50
36. Champlain improvement, No. 4, let on bid	2,645 00
37. Champlain improvement, No. 5, let on bid	7,684 00

38. Champlain improvement, No. 6, let on bid.....	$2,139 00
39. Champlain improvement, No. 7, let on bid.....	1,992 85
40. Champlain improvement, No. 8, let on bid.....	2,877 00
41. Main street, Fultonville, substructure.....	
42. Main street, Fultonville, superstructure.....	
43. Genesee river wall, let on bid	4,283 00
44. Caledonia avenue, Rochester, lift-bridge, substructure	
45. Caledonia avenue, Rochester, lift-bridge, superstructure.....	
46. Geneva street, Lyons, lift-bridge, substructure..	
47. Geneva street, Lyons, lift-bridge, superstructure	
	$513,839 91

48. Lock machinery, Erie, 23, 26, 46, 65 and 66.
49. Lock machinery, Erie, 53, 56, 60 and 62.
50. Lock machinery, Oswego, lock 9.
51. Lock machinery, Oswego, lock 10.
52. Rome bridge, George street, substructure.
53. Rome bridge, George street, superstructure.
54. Main street, Fultonville, substructure.
55. Main street, Fultonville, superstructure.
56. Oswego river obstructions, let on bid
57. Delaware river bridge, Tonawanda, substructure.
58. Delaware river bridge, Tonawanda, superstructure.
59. Mad Brook dam, Sherburne.

The average cost of twenty-six locks lengthened on Erie canal is $24,407.23, to which must be added $3,000 for engineering and inspection, making a total average per lock of $27,400.

Average bid per lock, Erie, 1886.....	$20,549 80
Average bid per lock, Erie, 1887.....	26,005 33
Average bid per lock, Erie, 1888.....	27,159 69
Average bid per lock, Erie, 1889.....	25,922 12

The following is a summary of work done in the department of the State Engineer and Surveyor during the past year, 30th September, 1889:

86.	Preliminary estimate	$1,031,868 84
73.	Contracts let	691,945 57
52.	Final accounts	512,057 89
40.	Contracts in progress	582,777 81

16.	Monthly estimates paid October, 1888	$26,196 00
22.	Monthly estimates paid November, 1888	36,897 53
24.	Monthly estimates paid December, 1888	31,782 19
33.	Monthly estimates paid January, 1889	84,538 67
30.	Monthly estimates paid February, 1889	67,355 00
29.	Monthly estimates paid March, 1889	63,088 40
33.	Monthly estimates paid April, 1889	53,325 74
11.	Monthly estimates paid May, 1889	24,085 85
19.	Monthly estimates paid June, 1889	42,462 15
13.	Monthly estimates paid July, 1889	27,433 70
13.	Monthly estimates paid August, 1889	18,238 67
12.	Monthly estimates paid September, 1889	49,964 55
255		$525,368 46

ENGINEERING EXPENSES FOR THE FISCAL YEAR.

ORDINARY REPAIR FUND.

Chapter 150, *Laws* 1888.

DIVISION.	CANALS.				
	Erie.	Champlain.	Oswego.	Cayuga and Seneca.	Black River.
Eastern	$5,215 10	$2,204 66	.....	.....	.....
Middle	6,120 13	.....	$689 91	$388 35	$617 87
Western	6,528 16	.....	.....	.....	.....
	$17,863 39	$2,204 66	$689 91	$388 35	$617 87

Total ..... $21,764.18.

DEFICIENCY ORDINARY REPAIR FUND.

(SURVEYS FOR CLAIMS BEFORE BOARD OF CLAIMS.)

Chapter 570, *Laws* 1889.

DIVISION.	CANALS.		
	Erie.	Champlain.	Chemung.
Eastern	$93 98	$876 62	.....
Middle	142 54	.....	$21 42
Western	1,962 69	.....	.....
	$2,199 16	$876 62	$21 42

Total ..... $3,097.20.

Chapter 249, *Laws* 1888.

DIVISION.	CANALS.					
	Erie.	Champlain.	Oswego.	Black River.	Oswego Lake outlet.	Oswegatchie river.
Eastern	$394 09	$105 06	.....	.....	$13 00	.....
Middle	1,094 26	.....	$122 86	$79 80	541 67	$114 35
Western	234 13	.....	.....	.....	.....	.....
	$1,722 48	$105 06	$122 86	$79 80	$554 67	$114 35

Total ..... $2,699.22.

EXTRAORDINARY IMPROVEMENTS.

ENLARGEMENT OF LOCKS.

Chapter 416, *Laws* 1888.

DIVISION.	CANALS.				
	Erie.	Champlain.	Oswego.	Black River.	Piers at Ithaca and Geneva.
Eastern	$10,395 13	$10,440 97	.....	.....	.....
Middle	129 54	.....	$3,854 50	$2,300 72	$499 97
Western	4,135 07	.....	.....	.....	.....
	$14,659 74	$10,440 97	$3,854 50	$2,300 72	$499 97

Total ..... $31,755.90.

BOTTOMING OUT CANAL.

Chapter 416, *Laws* 1888.

DIVISION.	CANALS.		
	Erie.	Albany basin.	Basin at Havana.
Eastern	$924 74	$1,749 01	.....
Middle	564 63	.....	$897 54
Western	1,939 39	.....	.....
	$3,428 76	$1,749 01	$897 54

Albany basin, chapter 568, Laws 1889	$6,075 31 96 28
Total	$6,171 59

ENLARGEMENT OF LOCKS.

Chapter 568, *Laws* 1889.

DIVISION.	CANALS.				
	Erie.	Champlain.	Oswego.	Black River.	Oneida river improvement.
Eastern	$358 67	$2,334 47	.....	.....	.....
Middle	75 14	.....	$636 94	$60 35	$4 95
Western	632 79	.....	.....	.....	.....
	$1,066 60	$2,334 47	$636 94	$60 35	$4 95

Total ..... $4,103.31.

Chapter 113, *Laws* 1887.

Middle division, Oswego canal $561 20

SPECIAL APPROPRIATION.

Eastern Division.

Chapter 106, Laws 1889, Hudson river improvement.. $4,736 15
Chapter 270, Laws 1889, examinations, surveys and maps 1,845 06

Chapter 318, Laws 1889, repairing Glens Falls feeder.	$1,175 46
Chapter 270, Laws 1889, water supply, Clinton prison.	201 84
Chapter 55, Laws 1889, vertical canal wall, Whitehall.	105 27
Chapter 85, Laws 1889, vertical canal wall, Schenectady.	80 97
Chapter 32, Laws 1889, vertical canal wall, Ilion.....	39 58
Chapter 320, Laws 1888, bridge, Broad street, Waterford	520 45
Chapter 400, Laws 1888, bridge, North Ferry street, Albany.....	397 61
Chapter 96, Laws 1888, bridge, Bridge street, Albany.	131 34
Chapter 51, Laws 1889, bridge, Liberty street, Schenectady	49 72
Chapter 149, Laws 1889, bridge, Main street, Fultonville	82 52
Total	$9,365 97

MIDDLE DIVISION.

Chapter 213, Laws 1889, vertical canal wall, Utica...	$13,50
Chapter 241, Laws 1889, canal wall and culvert, Oswego	113 09
Chapter 367, Laws 1888, removing obstruction, Oswego river.....	154,50
Chapter 274, Laws 1889, reservoir dam near Forestport pond	200,69
Chapter 150, Laws 1889, repairing second level, etc., Seneca Falls.....	71,29
Chapter 192, Laws 1888, improving harbor, Canandaigua lake	632 71
Chapter 206, Laws 1888, dredging Crooked lake outlet	248 95
Chapter 325, Laws 1888, improving channel, Seneca river.....	674 63
Chapter 155, Laws 1889, embankment, Mad brook, Sherburne.....	128 51
Chapter 557, Laws 1889, bridge, George street, Rome	59 99
Chapter 291, Laws 1888, bridge, Buffalo street, Ithaca	139 68
Chapter 13, Laws 1889, bridge, Buffalo street, Ithaca	425 18
Total	$2,862 63

WESTERN DIVISION.

Chapter 270, Laws 1889, examinations, surveys and maps	$2,599 55
Chapter 348, Laws 1889, South Tonawanda culverts	222 58
Chapter 351, Laws 1889, bridge, Main street, Rochester	1,026. 40
Chapter 481, Laws 1888, bridge, Culver street, Rochester	51 00
Total	$3,899 53

SUMMARY.

Ordinary Repair Fund.

Eastern division	$8,390 31	
Middle division	7,980 22	
Western division	8,491 85	
		$24,861 38

EXTRAORDINARY IMPROVEMENT.

Eastern division	$26,299 27	
Middle division	9,585 48	
Western division	6,707 25	
		42,592 00

SPECIAL APPROPRIATION.

Eastern division	$9,878 12	
Middle division	4,815 57	
Western division	4,133 66	
		18,827 35
Total engineering expenses		$86,280 73

WORKS UNDER CONTRACT.

The work now under contract for this winter:

On Eastern Division.—Locks 23, 24, 25 and 26 Erie; Champlain improvement, eight pieces; canal wall at Ilion; canal wall at Whitehall; canal wall at Schenectady; sluice at combines in Glens Falls feeder; Liberty street bridge at Schenectady.

On Middle Division.— Lock 12, Black River; locks 9 and 10, Oswego; Havana basin; canal wall at Oswego; Canandaigua harbor; canal wall at Utica; lock 8, Cayuga and Seneca.

On Western Division.— Locks 65 and 66, Erie; Culver street bridge, Rochester; Prospect street bridge, Lockport; Clyde lift-bridge, water power; Brockport lift-bridge, water power; Genesee river wall at State dam.

ORGANIZATION OF THE DEPARTMENT.

The organization of the department has been substantially the same as in previous years. Mr. A. S. C. Wurtele has been the Deputy State Engineer and Surveyor, and the division engineers in charge of the respective divisions have been: On the eastern division, Mr. Chapman L. Johnson; on the middle division, Mr. H. T. Beach, and on the western division, Mr. Thomas Evershed. The resident engineers have been: On the eastern division, Mr. John P. Kelly; on the middle, Mr. D. E. Whitford, and on the western, Mr. John Bisgood.

The engineering and clerical staff now consist of three division engineers, three resident engineers, nine assistant engineers, thirteen levelers, fifteen rodmen, twenty chainmen, one chief clerk, one engineer in charge of the work of the department connected with the lands of the State, one canal clerk, one stenographer and one clerk.

Reference is made to the reports of division engineers for important details and valuable suggestions.

CIVIL SERVICE EXAMINATIONS.

All appointments are made in accordance with the laws relating to the civil service of the State. The examinations for positions in this department require in their conduct careful reference both to the technical education and to the actual practical engineering experience properly required for securing to the State skilled assistance in the various grades of the service. There is always apt to be a tendency on the part of the examining boards for engineer-

ing positions to base the relative grading of candidates largely upon written replies to theoretical and mathematical questions. This is the easy way to make examinations. It is not so easy to frame questions and to conduct examinations so as to determine the capacity, actual or relative, of candidates for taking charge of and executing the practical duties of active engineering work. Just such duties, however, are what must be undertaken and executed by the members of this corps, if the State is to have honest service. A combination of suitable theoretical knowledge and considerable actual experience is a necessity for properly filling all but the lower grades in this department. A bright student just graduated from a good technical school can write replies to technical and mathematical questions, with more readiness than he will be able to command after he has had years of engineering experience. But it is absolutely unjust to the State to grade such a student so that he will be passed as ranking higher than an experienced engineer in an examination for a position which demands an experienced engineer.

It has been proven, however, that examinations can be conducted by experienced engineers, willing to accept the rather thankless task of examiners, so that the actual fitness of candidates can be determined. If this result can be secured at the examinations for positions in this department it will be of great value to the service of the State.

Respectfully submitted.

JOHN BOGART,
State Engineer and Surveyor.

NEW YORK STATE CANALS,

EASTERN DIVISION.

REPORT OF CHAPMAN L. JOHNSON,

DIVISION ENGINEER,

FOR THE

YEAR ENDING SEPTEMBER 30, 1889.

EASTERN DIVISION.

NEW YORK STATE CANALS,
OFFICE OF THE DIVISION ENGINEER, EASTERN DIVISION,
ALBANY, *October* 1, 1889.

Hon. JOHN BOGART, *State Engineer and Surveyor:*

SIR.—I have the honor to submit the following report on the condition of, and engineering operations on, the Eastern Division, for the year ending September 30, 1889.

The boundaries and subdivisions of the Division, with the mileage of canals, feeders, and river improvements, remain as stated, in detail, in my report for the year ending September 30, 1888.

WATER SUPPLY.

ERIE CANAL.

No change has been made in the sources of supply since the date of my last report. I would again call your attention to the remarks made therein, and, more particularly, to the great importance of speedily rebuilding the dam at Little Falls.

The year just closed has been one of extraordinarily great rainfall along the line of the Erie canal, and consequently, the supply of water has been ample.

CHAMPLAIN CANAL.

As on the Erie canal, the supply here has been ample during the entire year. The stoppage of leaks on the Glens Falls feeder would secure to that portion of the canal lying north of Northumberland an ample supply of water not only to meet present demands, but also for the needs of a prospective enlargement of the prism to the dimensions now adopted for all improvements, viz., forty-four feet width on bottom, with six feet depth of water. This is, however, a problem, the solution of which has been sought with more or less success, and at the cost of large expenditures, from the time of the construction of this feeder until the present, and there is yet a large proportion of the water taken in at the guard lock lost by leakage before it reaches the Champlain canal.

During the past winter, work has been done for the purpose of stopping these leaks at two points: First. Along a stretch of 1,400 feet,

extending easterly from a point 1,100 feet east of Glen street bridge in Glens Falls, about 720 linear feet of substantial vertical wall in cement has been substituted for the leaky wall which was found there, and though no repairs were made in the bottom of the prism, and the old wall on berme side, through which considerable water leaks, was not rebuilt, the result of this work has been satisfactory to a high degree, and I am of the opinion that fully two-thirds of the leakage along this portion of the feeder has been permanently cut off. Under the westerly 210 feet of this wall rock was not encountered, and the new wall rests on a timber foundation, with bottom of masonry, at an average elevation of eight feet and six inches below water surface, and toe of wall protected with concrete and puddle. The remainder of the wall rests on a rock foundation, its base varying in elevation between eight feet and six inches, and eleven feet, below water surface, with its toe protected by concrete. Second. From a point about 450 feet west of the last-named improvement, for a distance of 1,470 feet on berme side and 670 feet on tow-path side, substantial cement walls were built, founded on rock, at elevations varying from eight feet to ten feet five inches below water surface. This, with the wall on tow-path side, built in the winter of 1887 and 1888, gives us new walls, from said point 450 feet east of the first-named improvement (and on this 450 feet no serious leaks exist) easterly for 1,100 feet on the tow-path side and 1,470 feet on the berme.

The rock on which these walls rest, which extends entirely across the prism of the canal, is badly fissured, and therefore the entire bottom of canal, including the large basin lying within the limits of this improvement, was excavated, to elevations given above, for the bottom of walls, and the entire prism thus excavated was covered by a clay puddle eighteen inches thick, above which was placed a six-inch lining of broken stone. I regret to be obliged to report that this improvement has not as yet been productive of the benefits hoped for, and that serious leaks yet exist within its limits. Whether the failure is due to defect in plan on which the work was done, or to inefficient workmanship in placing the puddle in bottom of prism, can only be determined by an examination to be made at the close of navigation.

No final account has yet been rendered for this work, and therefore the State still holds the fifteen per cent usually retained from monthly estimates, and at the earliest practicable moment an examination will be made of the condition of the bottom of the canal, and the contractor will be required to remedy any defects in work which may be discovered, and such other steps will be taken as may be deemed advisable to render effective the work already done.

The leakage from the portion of the canal covered by this improvement has always been much larger than from any other equal area, and I feel confident that by the opening of navigation in 1890 it will be almost, if not entirely, checked. Further plans and estimates for continuing the work of stopping the leaks on this feeder, under provisions of chapters 318, Laws of 1888, and 568, Laws of 1889, will shortly be handed to you.

ERIE CANAL.

Prism, banks, walls and docking.

Owing to the enactment into law, of the principles contained in chapter 380, Laws of 1889, and the fact that appropriations for the operation and maintenance of the canals, for the past fiscal year, were based on rates of wages obtaining prior to the passage of said act, it has been found impossible to effect any extensive improvement in the prism, banks, etc., and therefore, with the exception of the bottoming out of the prism, under a special act (which will be referred to under the heading of extraordinary repairs), their condition remains, substantially, as stated in my last report.

During the coming winter, under provisions of chapter 85, Laws of 1889, about 2,000 feet of vertical wall in cement will be built on berme side of canal north of Rotterdam street, Schenectady. I am glad to see a movement made toward eliminating the danger to which continued navigation is exposed, by the decayed docking, to which I called especial attention in my last report. The cost however of replacing these long stretches of docking, which demand renewal at once, with cemented stone walls, will be so great, that I deem it advisable to repeat the opinion stated in my last report, that true economy would dictate the rebuilding of the timber structures.

NAVIGATION.

The only serious delays to navigation, during the year, were caused by the failure of two aqueducts. On July nineteenth a cloud burst caused a sudden and unprecedented rise in Otsquago creek, which is spanned by the Fort Plain aqueduct. The water in the creek rapidly rose, until it reached a level, about six inches above water surface of canal, and flowed over southerly spillway into canal; the easterly pier, on southerly side, gave way at 10 P. M., the sides of two spans were displaced, and, as the water in creek lowered, this level, five miles long, was emptied. A temporary wooden bent was constructed, the sides replaced, and feeding from Lock No. 33, began at noon of twenty-first instant, but as water had fallen considerably in the fourteen mile level, east of Lock No. 31, navigation was not fully resumed until the afternoon of the twenty-second. On September twentieth, at 4 A. M.,

the canal boat Jessie H. Clark ran into the second span from the north end of Tokkon creek (Van Wie's) aqueduct, on the tow-path side, knocking out the side of this panel, but not injuring the bottom. The side was replaced, and navigation resumed, on September twenty-second.

CONDITION OF STRUCTURES.

Locks.

The bottom of locks Nos. 4, 7, 28, 29, 30, 35, 36, 38, 39 and 44, have been partially replanked and concreted or grouted, as occasion required. The bottoms of many of the other locks, especially Nos. 9, 13, 14, 15, 18, 24 and 27, should be overhauled during the coming winter, and such repairs made as an inspection shall show to be necessary. Lock No. 23 will have berme chamber lengthened this winter; this lock is very narrow, and large boats can not pass through it; it will be necessary to have the face of the chamber walls, on one or both sides, as a survey may determine to be best, cut back far enough to allow free passage for boats. Nearly all the locks should be repointed. About twenty new lock-gates have been inserted during the year. Repairs have been made to the bulkheads of locks Nos. 23, 24, 25, 26 and 27, and a new river pier built, at the foot of lower lock, at the upper side cut in West Troy.

Aqueducts.

Slight repairs have been made to the Mohawk aqueducts. I am of the opinion that the Legislature should be asked to provide funds, at its approaching session, for the renewal of the trunks of both of these structures. The timber protection against ice, on the piers of the lower Mohawk aqueduct should also be renewed, as much of it has been entirely carried away by the ice. The trunk of Lashers aqueduct was renewed last spring. I would again call attention to the necessity of clearing out the creek channels, above and below most of the smaller aqueducts.

Waste-weirs.

These structures are in fair working condition with the exception of one in the basin at West Troy which badly needs a new bulkhead, No. 6, west of lock No. 20, No. 7, in Schenectady, and No. 17, west of lock No. 42. These latter three have failed by leakage either in the bottom or around the sides, or both, and have been filled up with embankment and thus rendered useless.

Concerning No. 6, both my predecessor and I have called attention to the advisibility of its renewal. In my opinion it is in a dangerous condition, though it has remained in substantially the same state for four years. No. 7 should either be rebuilt or a long spillway pro-

vided at or near the site of this weir. No. 17 is not essential to the successful operation of the canal, and its renewal can, I think, be indefinitely postponed.

Bridges and abutments.

Six bridges, viz.: Nos. 6, 40, 75, 105, 126 and 130, have been rebuilt during the past year. Twelve bridges, viz.: Nos. 11, 13, 60, 106, 131, 132, 135, 137, 144, 147, 157 and 162, should be rebuilt.

I am of the opinion that true economy would dictate the replacing of all wooden bridges, as they fall into decay, with iron structures; but if this can not be done, I most positively recommend that iron be exclusively used in the bottom chords of all bridges, whether road or farm, which may hereafter be built.

The berme abutment of bridge No. 158 (Litchfield street, Frankfort) has been rebuilt. Berme abutment of bridge No. 132 was dug behind and thrown back last spring. Berme abutments of bridges Nos. 61, 131 and 164 should be similarly treated during the coming season. The swing bridge at Lawrence street, Albany, should be extensively repaired. The swing bridge at West Troy side cut has been overhauled and now works satisfactorily.

EXTRAORDINARY IMPROVEMENT — LENGTHENING LOCKS, CHAPTER 416 LAWS OF 1888.

My last report gives a list of locks, for the lengthening of which, at the foot, on the berme side, contracts had then been let. The work on all of these locks was fully completed, prior to the opening of navigation, as follows:

Lock No. 27.— Costello, Neagle & Co., contractors. The new lock was founded on piles, driven to an average depth of twenty-five feet below the bottom of foundation timbers. Many large boulders, which proved a serious inconvenience in driving the piles, were encountered while driving through the first five feet, after which the piles penetrated a very soft material, until they brought up on hard foundation at the average elevation given above. There was, however, considerable variation in the elevation of this hard foundation, some of the piles being driven only fourteen feet, while others reached a depth of thirty-eight feet.

The face stone was obtained from the gray lime quarries at Chaumont, and the backing from the Mohawk blue lime quarries, contiguous to the work.

Lock No. 28.— Costello, Neagle & Co., contractors. A hard gravel bottom was found here, and piles could only be driven to an average depth of seven feet below the bottom of foundation timbers.

Face stone for this lock, as for lock 27, was obtained from the Chaumont quarries, and the backing is of Mohawk valley blue lime stone.

Lock No. 29.—Whalen Bros., contractors. A hard gravel bottom was found here; bearing piles, however, were used, and driven to a depth of seven feet below the bottom of timbers.

The greater portion of the face stone is the Onondaga county gray lime, obtained from the "Split Rock" quarry, which supply was supplemented from the Canajoharie quarry. The backing came from the Canajoharie quarry.

Lock No. 30.—Hughes Bros., contractors. A soft clay bottom was encountered here, and piles were driven to a depth of twenty feet without bringing up on any hard substance. The clay was especially soft towards the easterly end of lock, and consequently, under the easterly half of both north and south walls an extra row of piles were driven. This foundation has well sustained the masonry placed upon it, only a small crack having appeared at junction of old and new masonry on the north side.

The face stone is of Onondaga gray lime, obtained from the "Indian reservation," and the backing is of Mohawk valley blue lime.

The lengthening of this lock entailed the necessity of changing the location of the road bridge, crossing the canal at this point. Under this contract two new bridge approaches and abutments were constructed, and the old Whipple cast-iron arch bridge placed on the new abutments. To this and to the further fact, that the lift of this lock is two feet greater than that of the three other locks lengthened this year, is attributable the increased cost of this work over that of the others.

MACHINERY FOR DRAWING IN BOATS.

Nicholas and William Wemple, contractors.

Machinery for drawing in boats was placed on each of the locks lengthened this year, and therefore all the lengthened locks on this division are supplied with this very serviceable, if not indispensable, machinery.

In my last annual report, I had the honor of recommending some essential changes in the plans for this machinery. These changes, consisting of the dispensing with the vertical spool, and the substitution of cast-iron supports for the wooden frames, were carried into effect last winter and the improvement of the present plan of machinery over the old is manifest. There yet remains to be devised some scheme which will reduce the wear, from friction, etc., on the traction ropes and decrease the expense and trouble of the frequent renewal of them, which is now necessary. Wire cables were tried during the

past summer, on two of the locks on this Division, but the result of the experiment was not satisfactory.

DREDGING ALBANY BASIN.

Chapter 416, *Laws of* 1888, *and* 568, *Laws of* 1889.

Under the contract with J. Van Patten & Co., mentioned in my last report, the work of dredging out the deposit in this basin, was prosecuted, until the funds appropriated by chapter 416, Laws of 1888, were exhausted. On the closing up of work under this contract, the requisite seven feet of water had been obtained, over the entire area of the basin, with the following exceptions: First, material left under and near the bridges at State and Columbia streets, and the Hudson River railroad bridge; second, a bar of considerable area, lying between said railroad bridge and the ferry slip; and third, a bar 750 feet long and 150 feet wide, on the westerly side of the basin, north of Columbia street bridge. This latter bar, composed almost exclusively of deposits from the city sewers, was dredged over about two-thirds of its area, under the Van Patten contract, to a depth of five feet, but on the remaining third, this noxious material reached an elevation of two feet above mean low water.

Chapter 568, Laws of 1889, contains an appropriation of $7,000 for completing the bottoming out of this basin. A contract for dredging therein has been awarded to E. M. Payne, and work is now in progress thereunder. This latter law, however, limits work done under its provisions to points north of Columbia street.

I think it may be confidently asserted that never in the history of the Albany basin has so radical an improvement in its condition been made with the expenditure of an equal amount of money, as has been effected during the past year; and when work under the impending contract is closed, I believe it will be left in such a condition that for several years to come it will remain navigable, and cease to be a disease-breeding instrument.

I would, however, call your attention to the fact that so long as this basin retains its present form, and the sewers of the city of Albany are allowed to empty therein, any relief obtained by dredging must be temporary in its nature, and before any further large appropriations are made for dredging here, I hope the attention of the Legislature will be urgently called, to the consideration of the question, as to whether or not true wisdom would dictate the cutting off of the cause of trouble, which, in my opinion, could be done, by building a wall on the westerly side of the basin, on a line joining

present dock lines, at about their junction with Quackenbush and State streets, and obliging the city of Albany to build an intercepting sewer, back of said wall, and to continue the same to a point south of the southerly end of the basin.

By this means land of great value would be reclaimed to the State, the utility of the basin as a channel for navigation would not be lessened, and the constantly recurring demands for dredging here would cease to be heard, or, at least, would be heard at much longer intervals.

LENGTHENING LOCKS.

Chapter 568, *Laws of* 1889.

Locks Nos. 23, 24, 25 and 26, having been designated by the State Engineer and Surveyor, and the Superintendent of Public Works as the ones to be lengthened on this Division, under the provisions of this law, I prepared plans for the same, similar in general design to those heretofore adopted, and submitted the same to you, with the following estimate of cost:

NUMBER OF LOCK.	Estimated cost of work.	Estimated cost of engineering.	Total.
23	$29,933 00	$2,993 00	$32,926 00
24	25,292 10	2,529 90	27,822 00
25	30,378 00	3,038 00	33,416 00
26	28,998 50	2,899 50	31,898 00
Totals	$114,601 60	$11,460 40	$126,052 00

The above estimates contain no allowance for cost of inspection, advertising, or other contingencies of the work.

Contracts for this work have been let, as follows: For locks Nos. 23 and 24, to Hughes Bros., and for locks Nos. 25 and 26, to Costello, Neagle & Co., and the contractors are now engaged in preparing and delivering materials therefor.

LIFT-BRIDGE AT NORTH FERRY STREET, ALBANY.

In pursuance of the provisions of chapter 400, Laws of 1888, a lift-bridge has been erected over the canal at North Ferry street, Albany, to replace the Whipple cast-iron trapezoidal fixed bridge, previously there. The substructure was built by Valentine Brown, contractor, and the superstructure, by the Hilton Bridge Construction Company, contractors. The cutting down of the old approaches to this bridge has been a vast improvement to the street, and the benefit of the improved grade to persons conducting traffic over it is great.

Some difficulty in operating the bridge has been occasioned by the fact, that the bridge being so weighted, that the floor rises without the use of machinery, and the water pressure is used to lower and also to hold it down, while lowered, the vibrations incident to travel over the bridge, cause the cables to slip on the sheaves, and, after this slipping occurs, the floor will not go down to its proper position, until, by application of force in the counter direction, the cables are slipped back into position. With this exception the operation of the bridge is entirely satisfactory.

BRIDGE STREET BRIDGE, ALBANY.

Chapter 96, *Laws of* 1888.

Under the provisions of this law, a new berme abutment has been built here, and an iron superstructure placed thereon, with its tow-path end resting on the pier supporting the bridge over the Delaware and Hudson Canal Company's railroad at this point. The work was done by Sturtevant & Kellogg, contractors for the substructure, and the Hilton Bridge Company, contractors for the superstructure.

BRIDGE AT LIBERTY STREET, SCHENECTADY.

Chapter 51, *Laws of* 1889.

Based upon plans of a wrought-iron riveted lattice superstructure, furnished me from the office of the State Engineer and Surveyor, I have prepared plans and estimates for necessary work to be done on the substructure. At a letting, held September twenty-fourth, the whole work was awarded to W. H. Shepard & Co., but as the papers pertaining to the contract are not yet executed no note thereof appears in the table of pending contracts, hereto annexed.

BRIDGE AT MAIN STREET, FULTONVILLE.

Chapter 149, *Laws of* 1889.

Plans for a wrought-iron riveted lattice superstructure for this bridge having been presented to me by the State Engineer and Surveyor, I have prepared plans and estimates for the necessary work on the substructure, and proposals have been asked for by advertisement, but as yet no bid within the limits of the appropriation has been received, and consequently no contract has been awarded for this work.

BRIDGE AT LITCHFIELD STREET, FRANKFORT.

Chapter 70, *Laws of* 1888.

A wrought-iron riveted lattice superstructure has been built here during the past year by the Groton Bridge Company, contractors.

VERTICAL WALL ON THE BERME SIDE, WEST OF ROTTERDAM STREET, SCHENECTADY.

Chapter 85, *Laws of* 1889.

This law appropriates the sum of $18,500 for building vertical wall in cement, on berme side of the canal, westward from Rotterdam street bridge. I have prepared plans, specifications and estimates for building 2,000 feet of wall, running westward from said bridge. This contract has been awarded at prices considerably below my estimate, which will allow the building of about 400 additional feet of wall. At a letting held September twenty-fourth, the work was awarded to Casey, Murray & Co., but as the papers pertaining to the contract are not yet executed, no note thereof appears in the table of pending contracts hereto annexed.

VERTICAL WALL ON BERME SIDE, WEST OF ILION AQUEDUCT.

Chapter 32, *Laws of* 1889.

This law appropriates $15,000 for building a vertical cement wall on the berme side between westerly end of the Ilion aqueduct and a point 350 feet west of bridge No. 153, the distance between which points is about 3,900 feet. I have prepared plans and estimates for building 1,300 linear feet of wall between these points, this being about the length of wall which, under my estimate, could be built for the moneys appropriated. A contract for this work has been let to Martin, Sprague & Co., at prices so far below my estimate that between 400 and 500 additional feet of wall can be built.

BOTTOMING OUT ERIE CANAL.

Chapter 416, *Laws of* 1888; *Chapter* 110, *Laws of* 1889; *Chapter* 568, *Laws of* 1889.

As soon as possible after the passage of chapter 110, Laws of 1889, conferring on the Superintendent of Public Works the right to proceed with the bottoming out of the canal, otherwise than by contract, I organized six leveling parties, who proceeded to set grade stakes, for bottoming the canal to obtain a depth of seven feet of water. Stakes were set 100 feet apart on the tow-path side over the entire length of the Erie canal lying in this Division, and also on the berme side wherever it was deemed best to excavate the berme. On nearly the entire length of the canal the full seven feet of water was found to exist in the center, but large accumulations of silt had collected on both the berme and tow-path sides. The law in question was approved April 6, 1889, and the canal was opened for navigation on May 2, 1889, so that, allowing for the time necessary for the organization of forces,

only three weeks remained for actual work. It was deemed advisable to confine the bottoming out to the tow-path side of the canal, except where special conditions demanded the deepening of the whole prism or berme side only. The following table shows that 42.78 miles were improved.

Table showing length of the different levels on the Erie canal, and distances on which bottoming out was done.

BETWEEN LOCKS.	DISTANCES IN MILES.			
	Length of level.	Bottomed across entire prism.	Bottomed tow-path side only.	Bottomed berme side only.
1— 2	1.24	1.24	... .	.....
2— 3	5.24	1.33	3.30	... .
3—18	3.29	3.29	.....	.....
18—19	8.86	.....	2.78	.....
19—20	2.74	.....	.73	.....
20—21	3.22	.....	.11	.....
21—22	.18	.18	.....	.....
22—23	6.92	1.66	.51	.....
23—24	.79	.51	.....	.....
24—25	3.80	.25	1.20	.....
25—26	6.38	.40	1.13	.....
26—27	.20	.19	.....	....
27—28	5.21	.....	2.13	.07
28—29	1.97	.....	.94	.....
29—30	.63	.....	....	.....
30—31	13.85	.....	6.42	.....
31—32	6.32	.....	3.03	.....
32—33	5.11	.....	1.00	.....
33—34	2.57	.....	1.26	.....
34—35	3.18	.60	.....	.40
35—36	4.37	.10	1.40	.....
36—37	.62	.....	.30	.....
37—38	.16	.16	.. ..	.....
38—39	.22	.22	.....	.....
39—40	2.76	.....	1.10	.....
40—41	2.64	.....	1.20	.....
41—42	2.86	.15	1.00	.....
42—43	.26	.....	.....	... .
43—44	2.70	.06	.91	.....
44—45	1.23	.10	.23	.....
45—Oneida line	6.72	.16	1.03	.....
Totals	106.24	10.60	31.71	.47

The proportion existing between the distances shown to have been bottomed out, and the distances yet remaining to be cleaned, does not

by any means afford a just comparison between work already done and that remaining to be done, as almost invariably those portions of canal containing the greatest amount of sediment, were selected for improvement and a considerable portion of the canal on which no excavation was made requires little or no digging in order to secure the seven feet of water. The levels which were found to contain the greatest amount of sediment were between locks Nos. 1 and 2, between locks Nos. 2 and 3, and between locks Nos. 40 and 41.

In addition to the work shown to have been done by the above table, since the opening of navigation, the following dredging has been done: First, the little basin in Albany; second, the basin on the berme side at Port Jackson; third, the basin on the berme side above lock No. 28, known as Wamps; and fourth, the large deposit which had fallen from the high rock banks on the berme side of the canal, extending for one and a half miles below lock No. 21. This latter work has not yet been completed, but the dredge is now at work and will doubtless remove all of this material prior to the close of navigation.

The bar at the foot of lock No. 3 will also be dredged out before navigation closes.

CHAMPLAIN CANAL.

Prism-banks, etc.

A great improvement has been made in the condition of the prism and banks of this canal, at points covered by work done under contracts, which are treated of in detail hereafter, under the heading of extraordinary improvements. With the exception of these improvements the general condition of this canal remains, substantially, as it was at the time of my last report. The scarcity of funds, caused by the increased rate of wages paid to laborers on public works, has prevented any work being done and paid for from the ordinary maintenance fund, except that absolutely necessary to the contiuuance of navigation.

CONDITION OF STRUCTURES.

Locks.

Repairs needed to secure the efficient working of the locks have been made. The coping of lock No. 7 should be raised one foot, as the water, at its ordinary stage, stands only about four inches below the top of the coping, and a slight swell at the head of the lock, submerges the same. Elements of considerable failure, have been developed during the past year in lock No. 16. The walls on both sides of the chamber leak badly. There has been an evident movement of the chamber walls, and a stream of water, of considerable size, passes from the lock under the railroad and discharges into

Wood creek. A careful examination of the structure should be made at the close of navigation, and I fear this will develop the necessity of rebuilding a portion or all of the lock.

An examination has been made of the foundation of lock No. 3, on the Glens Falls feeder, and necessary repairs made. I believe this structure is now in a safe condition. Nearly all of the locks should be repointed.

Dams.

The buttresses and enlarged apron, built two years ago, at the dam across the Mohawk river at Cohoes, seem to have accomplished the desired objects and no further movement in the crest of the dam has been detected during the past year.

Repairs are needed to the apron and crest of the timber dam across the Hudson river at Troy.

The piers supporting the bridge over the dam across Wood creek, at lock No. 19, have been considerably injured by impact of ice and should be rebuilt. New bulkheads are also needed in this dam.

Aqueducts.

Those portions of the trunk of the Schuylerville aqueduct, not renewed in 1888, and also the tow-path bridge at this aqueduct have been renewed.

The westerly parapet wall and wing of the Fort Miller aqueduct should be rebuilt.

The trunks of the aqueducts at Moses kill and Fort Edward are getting too old for safety and should be renewed.

Waste-weirs.

A new waste-weir has been built at the head of lock No. 7, in connection with work done in this locality under contract with Monty & Parker, and a new bulkhead has been placed in the waste-weir, above lock No. 8.

New bulkheads are needed in the waste-weirs at Smith's and Dunham's basins; and new sluiceway should be built around the two combined, and five combined locks, on the Glens Falls feeder, with a new spillway and waste weir, above lock No. 3.

Culverts.

The condition of the parapet and wing walls of the culvert at Salisbury's, and of the arch under the tow-path, south of Fort Miller lock, remains as stated in my last report. I think it important that repairs should be made here soon.

The Walker culvert and the Division street culvert, both located in Whitehall, should be rebuilt or extensively repaired.

The culvert south of bridge No. 17 will be rebuilt during the coming winter, in connection with other work let to the Troy Public Works Company contractors.

Bridges and abutments.

In addition to the bridges built under contract, and which will be specifically mentioned hereafter, twelve bridges have been built during the year, viz.: Nos. 1, 14, 24, 26, 36, 45, 50, 57, 80, 104, 126 and 131.

The following twenty should be rebuilt: Nos. 8, 9, 11, 12, 13, 27, 34, 35, 41, 42, 53, 59, 72, 73, 103, 113, 115, 124 and 142, on the Champlain canal, and No. 1, on the Glens Falls feeder.

Berme abutments should be rebuilt at bridges Nos. 13, 34 and 115, and provisions for the building of them by contract during the coming winter will be made.

EXTRAORDINARY IMPROVEMENTS.

The policy outlined in my last report, of so applying the funds appropriated for the improvement of this canal, as to obtain, by excavation on the berme side, as long continuous stretches of improved prism of canal as possible, and at the same time to select the points to be improved from those portions of the canal where the prism is most contracted and therefore most difficult of navigation; and the avoiding of improvements in localities where expensive masonry work would have to be built, has been followed in selecting both the improvements made last winter and those which it is proposed to make during the coming year, and only in one or two cases where the extreme contraction of the channel, or very bad alignment rendered it important that work should be done at once, have locations been selected where the building of expensive vertical walls was necessary.

During the whole of the past year, Assistant Engineer E. B. Noyes has been engaged, with an engineering party, on work on this canal, and only after extended and careful surveys have decisions been arrived at in locating proposed improvements. So great a portion of this canal is too contracted both in width and depth to properly accommodate the traffic passing over it, that the problem of determining the points to which the funds appropriated should be applied, so as to obtain the greatest benefit therefrom, is one of considerable difficulty; but I think those having the best knowledge of the condition of this canal, and more particularly the boatmen navigating its waters, concur with me in the belief that the selections which have been made are judicious, and it is certain that this waterway within the past six years has been greatly improved. All improvements continue to be based on the obtaining of a prism forty-four feet wide on the bottom, with six feet depth of water.

IMPROVEMENTS UNDER CHAPTER 416, LAWS OF 1888.

My last report contains a list of nine pieces of work, for doing which plans and estimates had at the date thereof been made; subsequently, I had the honor of submitting two additional plans and estimates for work to be done under this law as follows:

No. 10.—For rebuilding berme abutment and building one bridge superstructure at bridge No. 131, the first south of Eastman's waste-weir, estimated cost $2,109. The berme abutment here had failed, and in planning its rebuilding it was located so as to obtain the standard prism of canal, and a lengthened superstructure placed on it.

No. 11.—For improving 1,550 feet of the Glens Falls feeder, eastward from a point 2,950 feet east of Glen street bridge in Glens Falls. Estimated cost, $27,783.

This improvement was designed for stopping the enormous leaks existing in this portion of the feeder, and consisted in the building of vertical wall in cement on the tow-path side along the entire length of the improvement, except that portion on which a new wall was built in 1888, and on the berme side along the entire 1,550 feet; it also consisted of excavating the entire prism to two feet below canal bottom, and protecting the same with a coating of puddle eighteen inches thick, and a lining six inches thick.

These plans and estimates having been duly approved, contracts were awarded for doing the work, as follows:

Contract No. 1, awarded to Monty & Parker.
Contract No. 2, awarded to Monty & Parker.
Contract No. 3, awarded to Flood & Riley.
Contract No. 4, awarded to Monty & Parker.
Contract No. 5, awarded to Monty & Parker.
Contract No. 6, awarded to Flood & Riley.
Contract No. 7, awarded to Flood & Riley.
Contract No. 8, awarded to Monty & Parker.
Contract No. 9, awarded to Flood & Riley.
Contract No. 10, awarded to David O. Briggs.
Contract No. 11, awarded to George R. Finch.

All of these several contracts have been fully completed and final accounts therefore rendered, except contract No. 11, of which I have spoken fully under the head of water supply.

The work on all of them, was done entirely in accordance with the proposed plans, except on contract No. 7, where the encountering of quicksand on the berme side, where rock had been expected, necessitated the building of a vertical wall three feet high and 165 feet long, surmounted by a timber docking; and on contract No. 8, where,

in consequence of the abandonment of the bridge by commutation made by the Superintendent of Public Works with the owner of adjoining land, the bridge and abutments were not built; and on contract No. 11, where the increased cost of the work necessitated the curtailment thereof, to the extent of 590 feet of vertical wall in cement; 450 feet of it being located on the tow-path side, and the remainder on the berme side.

LIFT-BRIDGE AT BROAD STREET, WATERFORD.

Chapter 320, *Laws of* 1888.

This structure has been completed during the year under contracts with Ira Parker for substructure, and the Hilton Bridge Company for superstructure. In order to obviate the difficulty referred to in connection with my remarks concerning the bridge at North Ferry street, Albany, which difficulty was also experienced in the operation of a similar bridge on the Western Division, the operation of the hoisting machinery on this bridge was reversed, and so arranged that the floor lowers by gravity, and is raised and held up by water-power.

This arrangement overcomes the difficulty referred to, but there are two objections to it. First. In case of temporary inability from accident or otherwise, to work the machinery, the floor will remain down and be in danger of being struck by boats until sufficient weight is placed in the counter-weight boxes to raise the same. Second. The motion of the piston is communicated to the gearing by means of a chain, the gradual wearing and consequent lengthening of which gradually reduces the lift of the floor, and, unless its adjustment is carefully watched, and its proper length maintained, the clearance is apt to become so much reduced that boats can not pass under the raised floor.

SHIP STREET BRIDGE, COHOES.

Chapter 168, *Laws of* 1887; *chapter* 126, *Laws of* 1888; *chapter* 552, *Laws of* 1889.

A wrought-iron riveted lattice bridge has been erected by the Hilton Bridge Company, contractors.

The contract for abutments and approaches, was let to James E. Flood on July 31, 1888. The abutments and so much of the approaches, as the funds appropriated by chapter 168, Laws of 1887, and chapter 126, Laws of 1888, would allow, have been completed. The contractor, however, is now engaged in enlarging the approaches and building wooden railing, funds for which have been provided by the appropriation contained in chapter 552, Laws of 1889, and therefore no final account has yet been rendered under the substructure contract.

WALL AT WHITEHALL.

Chapter 55, *Laws of* 1889.

This law appropriates the sum of $30,000 for building a stone wall on the tow-path side of the Champlain canal for a distance of 850 feet southwardly from lock No. 21. After a careful inspection of this locality, I have had plans made for this work, and estimate the cost thereof, exclusive of inspection and contingencies, at $20,434.

At a letting held on September twenty-fourth, the work was awarded to Jerry Adams, the lowest bidder, but the contract has not yet been executed.

IMPROVEMENTS UNDER CHAPTER 568, LAWS OF 1889.

This law having appropriated the sum of $130,000 for the improvement of the Champlain canal, and $16,000 for the improvement of the Glens Falls feeder, and directed the Superintendent of Public Works to make such improvements where the interests of commerce most require, after a joint inspection of the canal by the officers of this department and the Superintendent of Public Works, the proposed improvements were located, and I have prepared maps, plans and estimates for the work, as follows :

No. 1. — For improving 3,250 feet of canal northward from a point 4,200 feet north of lock No. 8.

This improvement consists in continuing northerly the standard prism obtained by contract No. 2, of 1888. In front of the two brickyards which lie within the above limits are bad bends, and contracted areas of prism ; along the high embankments, at the northerly end of improvement, the prism is much contracted, and the culvert here is too small to carry off the water fed to it; where embankments are not too high, the canal is to be widened on the tow-path side, and new slope walls built; along the high embankments where it is not deemed advisable to make any decided change in the alignment of canal, a widened prism will be obtained by the building of vertical cement walls on both sides of the canal, and the waterway under these embankments will be increased by substituting a double box culvert, with each opening 3′ x 4′ 4″ for the single box of 3′ x 3′ now there; and on the southerly end of the work piles will be driven to retain the quicksand on the berme side. Upon the completion of this work there will be secured two and eighty-five one-hundredths consecutive miles of canal north of lock No. 7, with prism of standard enlarged section.

No. 2.— For improving 11,800 feet of canal between Stillwater and Bemis Heights, extending northward from a point eighty feet north of bridge No. 32.

The prism along this stretch of canal is very contracted, and boats are frequently wedged here. It is proposed to obtain the standard prism by excavation on the berme side, a considerable portion of the same being in slate rock; to obtain widened prism under bridges by building vertical wall in front of towing path abutments; and to rebuild berme abutment of bridge No. 34, placing thereon a lengthened wooden bridge with iron lower chords.

In determining the width of prism on the bottom, a theoretical section of slope wall on tow-path side with slopes of one and one-quarter to one, is used. The building of this slope wall, however, is not contemplated at present, it being deemed the best policy to confine the expenditure of money so far as possible to the obtaining of enlarged prism. Contingent upon this improvement is the necessity of a change in alignment of about 733 feet of highway lying on westerly side of the canal.

No. 3. For improving 8,700 feet of canal south of Schuylerville, extending southward from a point 300 feet north of bridge No. 59.

This work begins at southerly end of contract No. 7, of 1888, and extends southerly to a junction with the improvement made under contract with Chester Ray in 1884 and 1885. This work is proposed on plans similar to those stated for contract No. 2, and on its completion an enlarged prism of canal will have been secured, extending, with the exception of a short distance through Schuylerville, from Coveville to Northumberland, a distance of five miles.

No. 4. For improving 325 feet of canal southward from lock No. 12.

This improvement is designed to relieve the delay to navigation incident to the extraordinarily contracted channel at the foot of this lock. This will be accomplished by the widening of the canal and the building of a dry vertical wall on the tow-path side.

No. 5. For improving 4,000 feet of canal, from lock No. 14 southward.

This improvement extends from lock No. 14 to the improvement made by contract No. 8, of 1888, and it is planned upon principles similar to those stated for contracts Nos. 2 and 3. Upon its completion we will have one continuous mile of enlarged canal.

No. 6. For improving 476 linear feet of the Champlain canal, north of its junction with the Glens Falls feeder.

This improvement consists in the cutting of a bad bend on the tow-path side of canal, which renders navigation difficult to boats passing between canal and feeder, and the building of slope wall along said improvement.

No. 7. For rebuilding one berme abutment and one bridge superstructure, etc., at bridge No. 115, south of Fort Ann.

The berme abutment having failed this improvement consists in building a new abutment, so located as to secure enlarged prism, and the placing thereon of a new wooden bridge, with iron chords, of necessary increased span.

No. 8. For building two new bridge abutments and one new bridge superstructure at bridge No. 13, first south of lock No. 7.

Both of these abutments having failed this improvement consists in the building of a new berme abutment, so located as to secure enlarged prism of canal; a tow-path abutment so located as to secure a width of tow-path of fourteen feet, and the placing thereon of a new wooden bridge with iron lower chords.

I estimate the cost of these several improvements as follows:

Contract No. 1	$40,367 00
Contract No. 2	35,721 00
Contract No. 3	22,268 00
Contract No. 4	2,989 00
Contract No. 5	10,374 00
Contract No. 6	2,754 00
Contract No. 7	2,564 00
Contract No. 8	3,501 00
	$120,538 00
Add for inspectors, advertising and contingencies	8,500 00
Total	$129,038 00

A contract has been awarded to the Troy Public Works Company for No. 1 of this list, and advertisements are now being published, asking for bids on the remainder.

Plans are being prepared and will shortly be submitted to you for work to be done under the appropriation of $16,000, for "Improving the Glens Falls feeder," contained in this law.

First. For rebuilding sluiceway, and building a new spillway and waste weir at the two combined locks (Nos. 2 and 3).

Second. For continuing the work of stopping leaks.

REPAIRING GLENS FALLS FEEDER.

Chapter 318, *Laws of* 1888.

The contract with George R. Finch for building 707 feet of vertical wall on the Glens Falls feeder, between points 1,092 and 2,500 feet east of Glen street bridge, this being the work referred to in my previous remarks (No. 1), under the head of water supply of the

Champlain canal, has been satisfactorily completed, and final accounts therefor rendered.

Plans have been prepared for building a discharge basin and rebuilding the sluiceway around the five combined locks (Nos. 6 to 10), and at a letting held September twenty-fourth, the work was awarded to Daniel Sturtevant, the lowest bidder, but the contract has not yet been entered into.

Plans are being prepared and will shortly be handed to you for improving 450 feet of the Glens Falls feeder, westward from the second bridge east of Glen street, Glens Falls. This is for completing that portion of contract No. 11, under chapter 416, Laws of 1888, cut short on account of lack of funds.

NAVIGATION.

Navigation has been uninterruptedly maintained during the year.

CLINTON PRISON, DANNEMORA.

The iron gate referred to in my last report has been built, and the mechanism for opening and closing the gate from a position in the adjacent guard tower, attached thereto.

This completes the work authorized by chapter 460, Laws of 1887, and the entire cost of completing the wall, surmounting the same with iron railing, building three guard towers, etc., etc., has been $16,077.53, leaving the sum of $3,922.47 to lapse into the treasury of the State.

The appropriation of an additional $1,500 recommended in my last report, for securing a water supply at this prison, was made by chapter 570, Laws of 1889. This taken in connection with the sum of $3,500, appropriated for the same purpose by chapter 270, Laws of 1888, makes available for this work the sum of $5,000.

The work is now in progress, pipe has been delivered and is being laid, the construction of dam is progressing, and on or before November thirtieth there will be secured a reservoir, with area of one-half acre and capacity of 650,000 gallons, fed at a minimum rate of seventy gallons per minute.

Three thousand and fifty feet of six-inch pipe, with a head of 192 feet to nozzle of lower hydrant, and four fire hydrants will be in position and connections made from main to the boilers in prison building and factory. The entire work will be done and from 500 to 800 feet of hose provided at a cost not exceeding the amount of the appropriation. To cover the cost of work done and materials furnished up to September 30, 1889, there have been certified for payment on this account bills amounting to $3,149.88.

CONCLUDING REMARKS.

Upon the opening of navigation next spring, boats in pairs will make the passage over that part of the Erie canal lying in this Division west of lock No. 18 (the head of the Cohoes ascent) without uncoupling more than eight times, viz.: At the foot of locks Nos. 19, 20, 21 (passing through lock No. 22, a distance of 1,000 feet before coupling up again) 36 (passing singly through the levels extending to the head of lock No. 39, a distance of one mile), 40, 41, 42 and 43. The great benefit of the lengthened locks to the commerce passing over this canal, has been fully demonstrated; and the wisdom of rapidly continuing this work until one tier of all the locks on the canal (except, perhaps, those at Cohoes and Lockport, where special difficulties are presented), have been lengthened, can not be questioned.

I hope, therefore, that the Legislature at its next session will recognize the advisability of proceeding at once toward the completion of this work, and will authorize and direct the lengthening of all of the twelve locks yet remaining unlengthened west of lock No. 18, during the winter of 1890 and 1891.

Funds should also be provided to continue, and if possible to complete, the bottoming out of the canal to the depth of seven feet.

On the completion of the improvements which it is proposed to make during the coming winter on the Champlain canal, we will have secured, out of the total sixty-six miles of this canal, about twenty miles of enlarged prism, not including those portions of Wood creek which need no improvement.

It is hoped that liberal appropriations will be continued for the prosecution of this work, and that as much as possible of the moneys thus appropriated will be applied to the obtaining of increased waterway; only that portion being applied to the obtaining of new, or repairs to old structures, as is necessary to the safe continuance of navigation. The work of stopping leaks on the Glens Falls feeder should be continued.

The application of tests to all cements offered for use on work under the supervision of this department, during the past year, has resulted in securing the best output of the various factories, from which the same has been obtained. These tests should be systematically continued, and all cements failing to come up to the required standard should be absolutely rejected. The results of these tests show a great variation in tensile strength as well as in other attributes of different samples of cements obtained from the same factories, and I believe better results will be obtained by applying tests to all cements offered for use, and accepting only those which come up to the

required standard, than by adopting the policy prevalent with many large consumers of cement, of allowing the use of only a few favored brands.

A special fund should be provided with which to defray the expenses of this department, contingent upon the making of surveys, maps, etc., for use in defending, before the Board of Claims, suits brought against the State, whether the same arise from causes incident to the operation or improvement of the canals, or are extraneous thereto.

ORGANIZATION AND WORK ON THE EASTERN DIVISION.

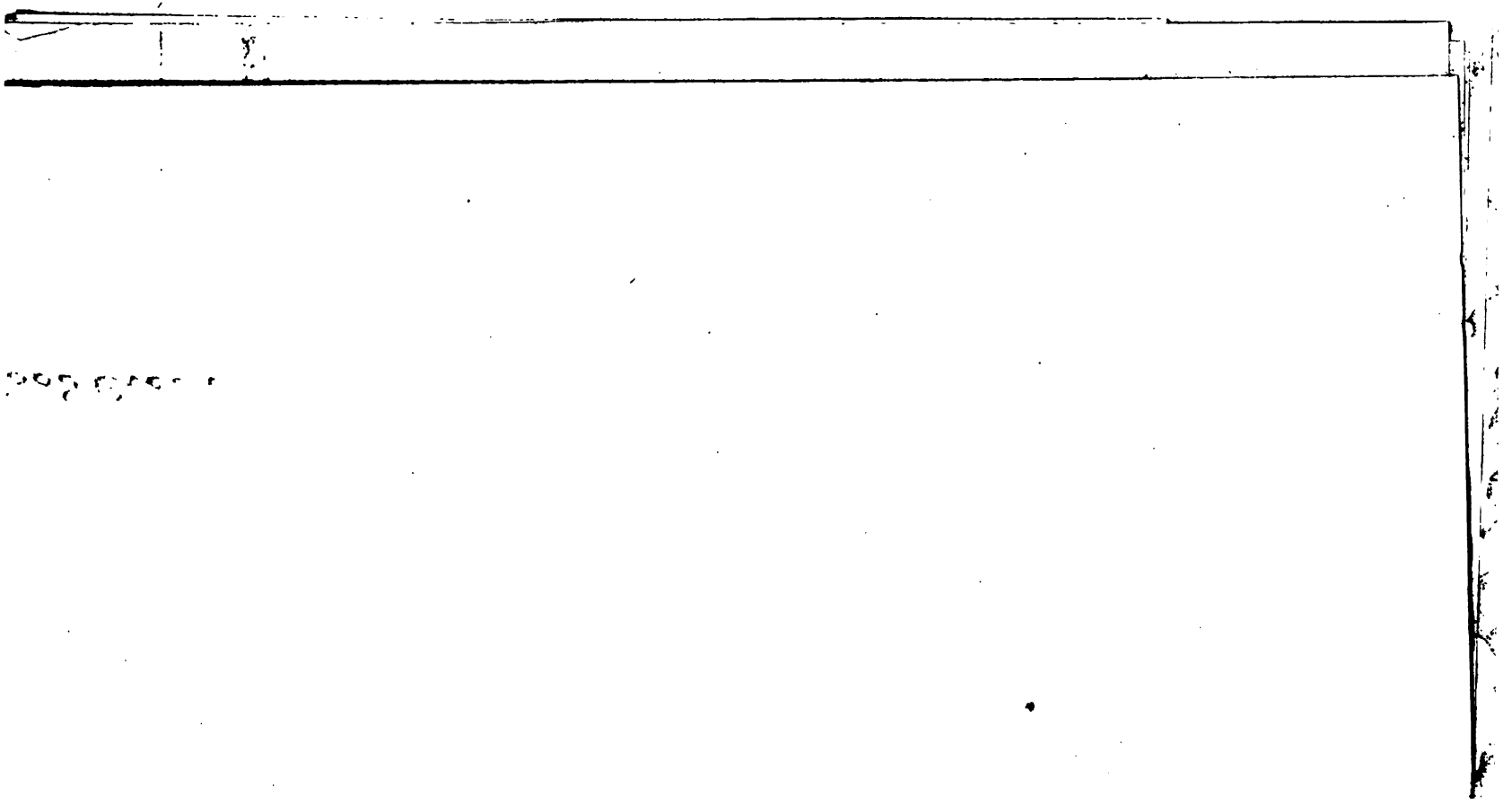
I have been assisted in the work on the division, during the past year, by John P. Kelly, resident engineer, E. B. Noyes, assistant engineer, in charge of the Champlain canal improvements, and George I. Bailey, Martin Schenck and T. C. Leutze, assistant engineers in charge of lock lengthening, and other special improvements heretofore detailed, and I desire to record my appreciation of the fidelity and ability with which each have performed the duties incident to his position, and to express to them as well as to the subordinate members of the corps, my thanks for the promptness with which they have responded to the demands made on them.

The work of the year has been the making of surveys, maps, plans and estimates for the various improvements heretofore detailed; the careful supervision of all contract work, and the making of partial estimates and final accounts for payments due to contractors; the making of surveys and maps and giving testimony in defense of the State, before the board of claims, in several cases, and the partial survey and preparation of maps (which work is now in progress) in twenty-eight cases pending before said board; and the performing of such professional work as the circumstances demanded, or as the Superintendent of Public Works requested, in connection with the ordinary repairs to the canal.

I hereto append tables giving the names, rank and compensation of engineers employed on this division during the past fiscal year, with the duration of services of each, and a summary of the total engineering expenditures; and also showing contracts completed and final accounts rendered during the year, and contracts pending on the 30th day of September, 1889.

I have the honor to be, very respectfully yours.

CHAPMAN L. JOHNSON,
Division Engineer.



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Statement showing names, rank, number of days and compensation of Engineers employed on the Eastern Division of the New York State canals, together with incidental expenses during the fiscal year ending September 30, 1889.

ORDINARY REPAIRS — ERIE CANAL.

Chapter 150, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.	Amount.
Chapman L. Johnson	Division engineer	.....	$2,400 00 per annum.	$1,600 00	$263 29	$1,863 29	
John P. Kelly	Resident engineer	.....	2,000 00 per annum.	355 23	8 95	364 18	
A. S. Kibbe	Assistant engineer in charge	10	6 00 per day	60 00	5 84	65 84	
George I. Bailey	Assistant engineer in charge	3	6 00 per day	18 00	7 29	25 29	
T. C. Leutze	Assistant engineer	29	5 00 per day	145 00	1 18	146 18	
G. D. Baltimore	Leveler	53	4 50 per day	238 50	2 88	241 38	
L. L. Gaul	Leveler	220	4 50 per day	990 00	3 41	993 41	
L. L. Gaul	Rodman	53⅓	3 50 per day	186 67	.....	186 67	
F. W. Battershall	Rodman	51	3 50 per day	178 50	1 38	179 88	
C. M. Pepson	Rodman	36	3 50 per day	126 00	7 46	133 46	
John Hickey	Rodman	22	3 50 per day	77 00	2 43	79 43	
William J. Smith	Rodman	12	3 50 per day	42 00	12 36	54 36	
William Miller	Chainman	36	2 50 per day	90 00	2 86	92 86	
James T. Gaffney	Chainman	1	2 50 per day	2 50	2 44	4 94	
						$4,431 17	
Incidental expenses.							
Labor					$89 00		
Stationery					328 15		
Postage and telegraph					110 13		
Miscellaneous					256 65		
						783 93	
							$5,215 10
Chapter 570, *Laws of* 1889.							
T. C. Leutze	Assistant engineer in charge	5	$6 00 per day	$30 00	$19 86	$49 86	
C. M. Pepson	Rodman	5	3 50 per day	17 50	4 72	22 22	
						$72 08	
Incidental expenses.							
Livery					$14 00		
Miscellaneous					7 85		
						21 85	
							93 93
							$5,309 03

ORDINARY REPAIRS — CHAMPLAIN CANAL.

Chapter 150, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.	Amount.
Chapman L. Johnson	Division engineer	.....	$2,400 00 per annum.	$800 00	$201 79	$1,001 79	
John P. Kelly	Resident engineer	.....	2,000 00 per annum.	82 10	9 20	91 30	
A. S. Kibbe	Assistant engineer in charge	8	6 00 per day	48 00	17 04	65 04	
L. L. Gaul	Leveler	27	4 50 per day	121 50	.....	121 50	
L. L. Gaul	Rodman	26¾	3 50 per day	93 33	.....	93 33	
F. W. Battershall	Rodman	46	3 50 per day	161 00	1 00	162 00	
C. M. Pepson	Rodman	17	3 50 per day	59 50	15 61	75 11	
William J. Smith	Rodman	24	3 50 per day	84 00	13 04	97 04	
William Miller	Chainman	112½	2 50 per day	281 25	9 12	290 37	
						$1,997 48	
Incidental expenses.							
Labor					56 00		
Stationery					81 33		
Postage and telegraph					46 52		
Miscellaneous					23 33		
						207 18	
							$2,204 66

Chapter 570, *Laws of* 1889.

John P. Kelly	Resident engineer	.....	$2,000 00 per annum.	$44 00	$15 60	$59 60	
T. C. Leutze	Assistant engineer in charge	41	6 00 per day	246 00	47 76	293 76	
C. M. Pepson	Rodman	22	3 50 per day	77 00	48 42	125 42	
John Hickey	Rodman	24	3 50 per day	84 00	53 38	137 38	
William J. Smith	Rodman	21	3 50 per day	73 50	41 70	115 20	
William Miller	Chainman	3	2 50 per day	7 50	7 86	15 36	
						$746 72	
Incidental expenses.							
Labor					$3 50		
Livery					79 00		
Postage and telegraph					2 50		
Miscellaneous					44 90		
						129 90	
							876 62
							$3,081 28

EXTRAORDINARY REPAIRS — ERIE CANAL (LENGTHENING LOCKS).

Chapter 416, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John P. Kelly	Resident engineer	.....	$2,000 00 per annum.	$756 71	$102 20	$858 91
George I. Bailey	Assistant engineer in charge	186	6 00 per day	1,116 00	90 01	1,206 01
Martin Schenck	Assistant engineer in charge	146	6 00 per day	876 00	18 53	894 53
A. S. Kibbe	Assistant engineer in charge	21	6 00 per day	126 00	.....	126 00
J. E. Ostrander	Leveler	244	4 50 per day	1,098 00	41 51	1,139 51
G. V. Rapp	Leveler	107	4 50 per day	481 50	4 56	486 06
G. D. Baltimore	Leveler	104	4 50 per day	468 00	.....	468 00
C. M. Pepson	Rodman	10	3 50 per day	35 00	16 76	51 76
F. W. Battershall	Rodman	94	3 50 per day	329 00	9 36	338 36
James Ryan, Jr.	Rodman	37	3 50 per day	129 50	3 33	132 83
W. J. Smith	Rodman	207	3 50 per day	724 50	31 18	755 68
John Hickey	Rodman	156	3 50 per day	546 00	4 15	550 15
J. H. Jones	Rodman	148	3 50 per day	518 00	11 21	529 21
C. H. Barber	Rodman	144	3 50 per day	504 00	19 52	523 52
William Miller	Chainman	90	2 50 per day	225 00	15 78	240 78
J. T. Gaffney	Chainman	150	2 50 per day	375 00	21 43	396 43
E. J. Waldron	Chainman	139	2 50 per day	347 50	3 40	350 90
F. Turner.	Chainman	124½	2 50 per day	311 25	3 42	314 67
						$9,363 31
Incidental expenses.						
Postage and telegraph					$68 51	
Labor					14 75	
Stationery					275 73	
Fuel and light					47 40	
Office rent					141 68	
Livery					277 00	
Miscellaneous					206 75	
						1,031 82
						$10,395 13

EXTRAORDINARY REPAIRS — CHAMPLAIN CANAL.

Chapter 416, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John P. Kelly	Resident engineer	.....	$2,000 00 per annum.	$482 59	$94 00	$576 59
E. B. Noyes	Assistant engineer in charge	226	6 00 per day	1,356 00	307 27	1,663 27
T. C. Leutze	Assistant engineer	5	5 00 per day	25 00	.....	25 00
H. M. Rood	Assistant engineer	210	5 00 per day	1,050 00	18 77	1,068 77
R. C. Strachan	Leveler	167	4 50 per day	751 50	33 97	785 47
J. M. Farley	Leveler	119	4 50 per day	535 50	20 70	556 20
A. P. Folwell	Leveler	65	4 50 per day	292 50	9 87	302 37
F. W. Battershall	Rodman	36	3 50 per day	126 00	85	126 85
L. T. Carver	Rodman	215	3 50 per day	752 50	92 12	844 62
James C. Dougrey	Rodman	230	3 50 per day	805 00	10 92	815 92
Edward Styring	Rodman	161	3 50 per day	563 50	8 87	572 37
William Miller	Chainman	9	2 50 per day	22 50	.....	22 50
W. E. Lutjens	Chainman	178	2 50 per day	445 00	59 31	504 31
J. A. Shanahan	Chainman	220	2 50 per day	550 00	17 44	567 44
C. H. Mory	Chainman	172	2 50 per day	430 00	17 52	447 52
						$8,879 20
Incidental expenses.						
Postage and telegraph					$61 81	
Labor					.....	
Stationery					208 27	
Fuel and light					34 68	
Office rent					120 00	
Livery					969 00	
Miscellaneous					168 01	
						1,561 77
						$10,440 97

EXTRAORDINARY REPAIRS — ERIE CANAL (BOTTOMING OUT).

Chapter 416, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George I. Bailey	Assistant engineer in charge	7	$6 00 per day	$42 00	$31 60	$73 60
A. S. Kibbe	Assistant engineer in charge	11	6 00 per day	66 00	17 44	83 44
T. C. Leutze	Assistant engineer	3	5 00 per day	15 00	11 14	26 14
J. E. Ostrander	Leveler	9	4 50 per day	40 50	6 44	46 94
G. D. Baltimore	Leveler	20	4 50 per day	90 00	19 38	109 38
C. M. Pepson	Rodman	18	3 50 per day	63 00	41 08	104 08
F. W. Battershall	Rodman	18	3 50 per day	63 00	48 05	111 05
W. J. Smith	Rodman	4	3 50 per day	14 00	5 66	19 66
John Hickey	Rodman	1	3 50 per day	3 50	74	4 24
J. H. Jones	Rodman	8	3 50 per day	28 00	13 64	41 64
Chas. H. Barber	Rodman	5½	3 50 per day	19 25	6 68	25 93
William Miller	Chainman	18	2 50 per day	45 00	17 03	62 03
J. T. Gaffney	Chainman	1	2 50 per day	2 50	50	3 00
E. J. Waldron	Chainman	7	2 50 per day	17 50	4 64	22 14
						$733 27
Incidental expenses.						
Labor					$5 50	
Postage and telegraph					2 37	
Livery					105 00	
Miscellaneous					78 60	
						191 47
						$924 74

DREDGING IN THE ALBANY BASIN.

Chapter 416, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.	Amount.
John P. Kelly	Resident engineer	.....	$2,000 00 per annum.	$10 93	.....	$10 93	
T. C. Leutze	Assistant engineer in charge	161	6 00 per day	966 00	.....	966 00	
C. M. Pepson	Rodman	134	3 50 per day	469 00	$0 20	469 20	
William Miller	Chainman	29	2 50 per day	72 50	.....	72 50	
						$1,518 63	
Incidental expenses.							
Labor					$15 00		
Stationery					60 87		
Fuel and light					6 00		
Office rent					21 00		
Miscellaneous					127 51		
						230 38	
							$1,749 01
Chapter 568, *Laws of* 1889.							
C. M. Pepson	Rodman	15	$3 50 per day	$52 50	.....	$52 50	
Incidental expenses.							
Stationery					$24 48		
Miscellaneous					19 30		
						43 78	
							96 28
							$1,845 29

REPAIRING GLENS FALLS FEEDER.

Chapter 318, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
E. B. Noyes	Assistant engineer in charge	30	$6 00 per day	$180 00	$9 28	$189 28
H. M. Rood	Assistant engineer	9	5 00 per day	45 00	3 52	48 52
J. M. Farley	Leveler.	67	4 50 per day	301 50	22 29	323 79
A. P. Folwell	Leveler.	28	4 50 per day	126 00	6 02	132 02
L. T. Carver	Rodman.	49	3 50 per day	171 50	21 09	192 59
J. C. Dougrey	Rodman.	9	3 50 per day	31 50	5 05	36 55
J. A. Shanahan	Chainman	9	2 50 per day	22 50	3 74	26 24
W. E. Lutjens	Chainman	72	2 50 per day	180 00	28 60	208 60
						$1,157 59
Incidental expenses.						
Postage and telegraph					$1 63	
Livery					7 00	
Miscellaneous					9 24	
						17 87
						$1,175 46

EXTRAORDINARY REPAIRS — CHAMPLAIN CANAL.

Chapter 568, *Laws of* 1889.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.	Amount.
E. B. Noyes	Assistant engineer in charge	55	$6 00 per day	$330 00	$57 23	$387 23	
H. M. Rood	Assistant engineer	53	5 00 per day	265 00	10 31	275 31	
J. M. Farley	Leveler	47	4 50 per day	211 50	11 46	222 96	
R. S. Strachan	Leveler	15	4 50 per day	67 50	.....	67 50	
L. T. Carver	Rodman	47	3 50 per day	164 50	12 68	177 18	
Wm. J. Smith	Rodman	9	3 50 per day	31 50	60	32 10	
James C. Dougrey	Rodman	55	3 50 per day	192 50	4 94	197 44	
Edw. Styring	Rodman	54	3 50 per day	189 00	.....	189 00	
John A. Shanahan	Chainman	56	2 50 per day	140 00	5 19	145 19	
W. E. Lutjens	Chainman	47	2 50 per day	117 50	22 49	139 99	
C. H. Mory	Chainman	56	2 50 per day	140 00	7 32	147 32	
						$1,981 22	
Incidental expenses.							
Labor					$4 25		
Postage and telegraph					11 07		
Stationery					18 00		
Office rent					36 00		
Fuel and lights					6 40		
Livery					187 50		
Miscellaneous					90 03		
						353 25	
							$2,334 47

EXTRAORDINARY REPAIRS — ERIE CANAL. (*Lengthening locks.*)

John P. Kelly	Resident engineer	.....	$2,000 00 per annum.	$99 00	.....	$99 00	
John E. Ostrander	Leveler	11	4 50 per day	49 50	.....	49 50	
F. W. Battershall	Rodman	48	3 50 per day	168 00	$0 68	168 68	
						$317 18	
Incidental expenses.							
Stationery						41 49	
							358 67
							$2,693 14

BROAD STREET BRIDGE AT WATERFORD, N. Y.

Chapter 320, *Laws of* 1889.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John P. Kelly	Resident engineer	.....	$2,000 00 per annum.	$60 42	$9 80	$70 22
H. M. Rood	Assistant engineer	40	5 00 per day	200 00	25 45	225 45
F. W. Battershall	Rodman	5	3 50 per day	17 50	1 10	18 60
James C. Dougrey	Rodman	23	3 50 per day	80 50	17 00	97 50
Edw. Styring	Rodman	4	3 50 per day	14 00	.....	14 00
John A. Shanahan	Chainman	25	2 50 per day	62 50	18 25	80 75
William Miller	Chainman	3	2 50 per day	7 50	2 20	9 70
						$516 22
Incidental expenses.						
Postage and telegraph					$2 78	
Miscellaneous					1 45	
						4 23
						$520 45

NORTH FERRY STREET BRIDGE, ALBANY, N. Y.

Chapter 400, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John P. Kelly	Resident engineer	.....	$2,000 00 per annum.	$32 58	$0 40	$32 98
T. C. Leutze	Assistant engineer in charge	31	6 00 per day	186 00	.....	186 00
T. C. Leutze	Assistant engineer	8	5 00 per day	40 00	2 48	42 48
F. W. Battershall	Rodman	2	3 50 per day	7 00	.....	7 00
C. M. Pepson	Rodman	35	3 50 per day	122 50	.....	122 50
William Miller	Chainman	2	2 50 per day	5 00	40	5 40
						$396 36
Incidental expenses.						
Miscellaneous						1 25
						$397 61

BRIDGE STREET BRIDGE, ALBANY, N. Y.

Chapter 96, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John P. Kelly	Resident engineer	.....	$2,000 00 per annum.	$43 44	$0 50	$43 94
T. C. Leutze	Assistant engineer in charge	7	6 00 per day	42 00	.....	42 00
F. W. Battershall	Rodman	1	3 50 per day	3 50	.....	3 50
C. M. Pepson	Rodman	9	3 50 per day	31 50	10	31 60
William Miller	Chainman	4	2 50 per day	10 00	30	10 30
						$131 34

LIBERTY STREET BRIDGE, SCHENECTADY, N. Y.

Chapter 51, *Laws of* 1889.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George I. Bailey	Assistant engineer in charge	3	$6 00 per day	$18 00	$0 68	$18 68
J. E. Ostrander	Leveler	4	4 50 per day	18 00	.....	18 00
Wm. J. Smith	Rodman	1	3 50 per day	3 50	1 18	4 68
C. M. Pepson	Rodman	1	3 50 per day	3 50	1 18	4 68
William Miller	Chainman	1	2 50 per day	2 50	1 18	3 68
						$49 72

MAIN STREET BRIDGE, FULTONVILLE, N. Y.

Chapter 149, *Laws of* 1889.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George I. Bailey	Assistant engineer in charge	4	$6 00 per day	$24 00	$2 26	$26 26
J. E. Ostrander	Leveler	12	4 50 per day	54 00	2 26	56 26
						$82 52

VERTICAL WALL AT ILION, N. Y.

Chapter 32, *Laws of* 1889.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
F. W. Battershall	Rodman	4	$3 50 per day	$14 00	6 26	$20 26
William Miller	Chainman	3	2 50 per day	7 50	10 82	18 32
						$38 58
Incidental expenses.						
Labor						1 00
						$39 58

VERTICAL WALL AT SCHENECTADY, N. Y.

Chapter 85, *Laws of* 1889.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John P. Kelly	Resident engineer	.....	$2,000 00 per annum.	$33 00	$2 93	$35 93
John Hickey	Rodman	6	3 50 per day	21 00	1 86	22 86
Wm. J. Smith	Rodman ..	6	3 50 per day	21 00	1 18	22 18
						$80 97

VERTICAL WALL AT WHITEHALL, N. Y.

Chapter 55, *Laws of* 1889.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
E. B. Noyes	Assistant engineer in charge....	4	$6 00 per day	$24 00	$5 26	$29 26
H. M. Rood	Assistant engineer	2	5 00 per day	10 00	5 60	15 60
J. M. Farley	Leveler	1	4 50 per day	4 50	3 38	7 88
Edw. Styring	Rodman	2	3 50 per day	7 00	4 26	11 26
L. T. Carver	Rodman	3	3 50 per day	10 50	3 63	14 13
W. E. Lutjens	Chainman	1	2 50 per day	2 50	3 38	5 88
C. H. Mory	Chainman	2	2 50 per day	5 00	4 26	9 26
	Incidental expenses.					$93 27
Labor					$12 00	12 00
						$105 27

For Making Surveys and Maps for Use of State Board of Claims.

Chapter 249, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
T. C. Leutze	Assistant engineer in charge	17	$6 00 per day	$102 00	$62 01	$164 01
G. I Bailey	Assistant engineer in charge	13	6 00 per day	78 00	39 46	117 46
C. M. Pepson	Rodman	12	3 50 per day	42 00	23 26	65 26
Wm. J. Smith	Rodman	9	3 50 per day	31 50	17 54	49 04
F. W. Battershall	Rodman	2	3 50 per day	7 00	.....	7 00
John Hickey	Rodman	9	3 50 per day	31 50	10 46	41 96
William Miller	Chainman	2	2 50 per day	5 00	6 02	11 02
						$455 75
Incidental expenses.						
Livery					$55 50	
Miscellaneous					90	
						56 40
						$512 15

For Making Examination and Maps Required by the State Engineer and Surveyor.

Chapter 270, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. S. Kibbe	Assistant engineer in charge	154	$6 00 per day	$924 00	$169 97	$1,093 97
T. C. Leutze	Assistant engineer in charge	15	6 00 per day	90 00	33 92	123 92
C. E. Phelps	Surveyor	50	5 00 per day	250 00	22 05	272 05
Wm. J. Kiernan	Chainman	69	2 50 per day	172 50	78 35	250 85
						$1,740 79
Incidental expenses.						
Postage and telegraph					$12 02	
Labor					38 75	
Miscellaneous					53 50	
						104 27
						$1,845 06

Clinton Prison Water Supply.

Chapter 270, *Laws of* 1888.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Chapman L. Johnson	Division engineer	.....	$3,400 00 per annum.	.....	$14 06	$14 06
J. E. Ostrander	Leveler	25	4 50 per day	$112 50	22 66	135 16
						$149 22
Incidental expenses.						
Postage and telegraph					$5 52	
Miscellaneous					47 10	
						52 62
						$201 84

The foregoing tables are summarized as follows:

ORDINARY REPAIRS.			
Erie canal		$5,309 03	
Champlain canal		3,081 28	
			$8,390 31
EXTRAORDINARY REPAIRS.			
Lengthening locks, Erie canal, chapter 416, Laws of 1888	$10,395 13		
Bottoming out Erie canal, chapter 416, Laws of 1888	924 74		
Bottoming out Albany basin, chapter 416, Laws of 1888	1,749 01		
Improving Champlain canal, chapter 416, Laws of 1888	10,440 97		
		$23,509 85	
Lengthening locks, Erie canal, chapter 568, Laws of 1889	$358 67		
Bottoming out Albany basin, chapter 568, Laws of 1889	96 28		
Improving Champlain canal, chapter 568, Laws of 1889	2,334 47		
		2,789 42	
Repairing Glens Falls' feeder, chapter 318, Laws of 1888		1,175 46	
Lift-bridge at North Ferry street, Albany, chapter 400, Laws of 1888		397 61	
Bridge street bridge at Albany, chapter 96, Laws of 1888		131 34	
Lift-bridge at Broad street, Waterford, chapter 320, Laws of 1889		520 45	
Bridge at Liberty street, Schenectady, chapter 51, Laws of 1889		49 72	
Bridge at Main street, Fultonville, chapter 149, Laws of 1889		82 52	
Vertical wall at Ilion, chapter 32, Laws of 1889		39 58	
Vertical wall at Whitehall, chapter 55, Laws of 1889		105 27	
Vertical wall at Schenectady, chapter 85, Laws of 1889		80 97	
			28,882 19
SPECIAL SURVEYS.			
Making surveys and maps for use of the State Board of Claims, chapter 249, Laws of 1888		$512 15	
Making surveys and maps required by State Engineer and Surveyor, chapter 270, Laws of 1888		1,845 06	
Clinton prison water supply, chapter 270, Laws of 1888		201 84	
			2,559 05
			$39,831 55

TABLE OF CONTRACTS, ON EASTERN DIVISION, COMPLETED DURING THE YEAR ENDING SEPTEMBER 30, 1889.

ERIE CANAL.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	LEGISLATIVE ACT.		Appropriation.	Engineer's estimate at contract price.*	Final estimate.	Remarks.
			Chapter.	Year.				
Costello, Neagle & Co....	Aug. 27, 1888	Lengthening at the foot, lock No. 27.....	416	1888		$24,356 00	$25,270 63	Additional piles driven.
Costello, Neagle & Co....	Aug. 27, 1888	Lengthening at the foot, lock No. 28.....	416	1888		26,595 00	25,636 02	
Whalen Bros.....	Aug. 27, 1888	Lengthening at the foot, lock No. 29.....	416	1888	$200,000 00 for 7 locks	24,529 00	24,100 14	
Hughes Bros.....	Aug. 27, 1888	Lengthening at the foot, lock No. 30.....	416	1888		32,851 65	34,172 81	Additional piles driven.
Nicholas Wemple and William H. Wemple....	Aug. 18, 1888	Machinery for drawing boats into locks 27, 28, 29, 30, 63 and 64.....	416	1888		6,600 00	6,600 00	
John Van Patten & Co....	Aug. 29, 1888	Bottoming out the Albany basin.....	416	1888	40,000 00	33,950 00	34,727 87	
Groton Bridge and Manufacturing Co.....	Jan. 9, 1889	Iron bridge superstructure for the Litchfield St. bridge, Frankfort ..	70	1888	3,000 00	2,394 00	2,474 00	
Sturtevant & Kellogg	Oct. 12, 1888	Berme abutment for Bridge street bridge, Albany	96	1888	5,000 00	1,334 73	1,553 27	
Hilton Bridge Construction Co	Dec. 5, 1888	Iron superstructure for the Bridge St. bridge, Albany	96	1888		2,975 00	3,125 00	
Valentine Brown	Nov. 28, 1888	Substructure for the lift-bridge over Erie canal at N. Ferry St., Albany.	400	1888	14,000 00	2,116 20	2,786 00	
Hilton Bridge Construction Co	Feb. 6, 1889	Iron lift-bridge superstructure at N. Ferry street, Albany..... ...	400	1888		9,375 00	9,834 29	
						$167,076 60	$170,280 43	

CHAMPLAIN CANAL.

Monty and Parker.....	Nov.	10, 1888	To protect the berme bank and rebuild the waste-weir at the head of lock No. 7.....	416	1888		$2,334 00	$2,700 08	
Monty and Parker.....	Nov.	10, 1888	Improving 10,300 feet of canal between lock No. 7 and a point 4,100 feet north of lock No. 8.....	416	1888		19,977 50	19,517 98	
Flood and Riley	Nov.	10, 1888	Improving 635 feet of canal from lock No. 8 northward.....	416	1888		3,903 25	4,426 91	
Monty and Parker.....	Nov.	10, 1888	Improving 440 feet of canal north of first bridge north of Wilbur's basin waste-weir.....	416	1888		6,978 00	6,212 46	
Monty and Parker.....	Nov.	10, 1888	Improving 175 feet of canal at Salisbury's culvert.....	416	1888		1,575 00	2,040 42	Wall founded deeper than provided for in preliminary estimate.
Flood and Riley	Nov.	8, 1888	Improving 1,500 feet of canal south of bridge No. 52.....	416	1888	$105,000 00	12,894 50	11,898 59	
Flood and Riley	Nov.	10, 1888	To improve 1,280 feet of canal about three-fourths mile south of Schuylerville opposite Gate's headquarters ..	416	1888		4,585 00	3,944 28	
Monty and Parker.....	Nov.	10, 1888	Improving 1,160 feet of canal and build two bridge abutments and one bridge superstructure at bridge No. 80.....	416	1888		5,195 50	5,355 69	
Flood and Riley	Nov.	10, 1888	Rebuilding berme abutment at bridge No. 88.....	416	1888		1,240 30	1,274 89	
David O. Briggs	Jan.	4, 1889	Rebuilding the berme abutment and rebuilding the superstructure of bridge No. 130.....	416	1888		1,770 30	1,800 13	
James E. Flood.	Dec.	1, 1888	Wooden bridge and abutments over the Glens Fall's feeder of Ferry street, Sandy Hill	570	1888	2,500 00	1,863 80	1,888 51	

TABLE OF CONTRACTS, ON EASTERN DIVISION, ETC.—CHAMPLAIN CANAL — (*Concluded*).

NAME OF CONTRACTOR.	Date of contract.	Character of work.	LEGISLATIVE ACT. Chapter.	LEGISLATIVE ACT. Year.	Appropriation.	Engineer's estimate at contract prices.	Final estimate.	Remarks.
George R. Finch.....	Dec. 27, 1888	Rebuilding 770 feet of vertical wall on Glens Fall's feeder between points 1092 and 2500 east of Glen street bridge, Glens Falls....	318	1888	$20,000 00	$5,430 00	$8,420 06	Wall founded deeper than provided for in preliminary estimate.
Hilton Bridge Company .	July 23, 1888	To construct the iron superstructure at Ship street, Cohoes	168	1887	†8,000 00	1,868 00	1,893 00	
Ira Parker	Feb. 6, 1889	Substructure for the lift-bridge at Broad street, Waterford.....	126	1888				
Hilton Bridge Company .	April 2, 1889	Wrought iron lift-bridge superstructure at Broad st., Waterford..	320	1888	10,000 00	1,966 75	2,099 49	
			320	1888		6,600 00	6,776 00	
Total.....						$76,181 90	$80,248 44	

* Figures in this column are obtained by deducting from footing of contractor's bid the estimated value of old materials to be used as the same appears in engineer's preliminary estimate.

† This appropriation covers both sub and superstructure.

TABLE OF CONTRACTS PENDING ON THE EASTERN DIVISION, ON THE 30TH DAY OF SEPTEMBER, 1889.

ERIE CANAL.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Appropriation.	Legislative Act. Chap.	Legislative Act. Year.	Engineer's preliminary estimate.	Engineer's estimate at contract prices.	Payments to date.
Martin Sprague & Co	Sept. 16, 1889	Building 1,300 feet of vertical wall west of the Ilion aqueduct	$15,000	32	1889	$13,338 00	$10,439 50	.....
Hughes Bros	Aug. 26, 1889	Lengthening at the foot, lock No. 23	215,000 for length'g 8 locks.	568	1889	29,933 00	31,561 40	.....
Hughes Bros	Aug. 26, 1889	Lengthening at the foot, lock No. 24				25,292 00	29,494 75	.....
Costello, Neagle & Co	Aug. 21, 1889	Lengthening at the foot, lock No. 25				30,378 00	33,267 50	.....
Costello, Neagle & Co	Aug. 21, 1889	Lengthening at the foot, lock No. 26				28,998 00	31,130 00	.....
E. M. Payn	Sept. 26, 1889	Bottoming out the Albany basin	$7,000	568	1889	25c. cu. yd.	12 9-10c. cu. yd.	$748 00

CHAMPLAIN CANAL.

James E. Flood	July 31, 1888	Substructure of Ship street bridge, Cohoes	*$6,000	168	1887	$6,156 00	$5,754 00	$4,930 00
			2,000	126	1888	.....	.....	.....
			1,500	552	1889	1,500 00	1,500 00	.....
George R. Finch	Jan. 3, 1889	Improving 1,550 feet of Glens Falls feeder	105,000	416	1888	25,257 50	22,792 50	21,958 00
Troy Public Works Co	Sept. 21, 1889	Improving 3,250 feet of the Canal, south of lock No. 8	130,000	568	1889	36,697 75	31,101 75	.....

* These appropriations cover both substructure and superstructure.

NEW YORK STATE CANALS,

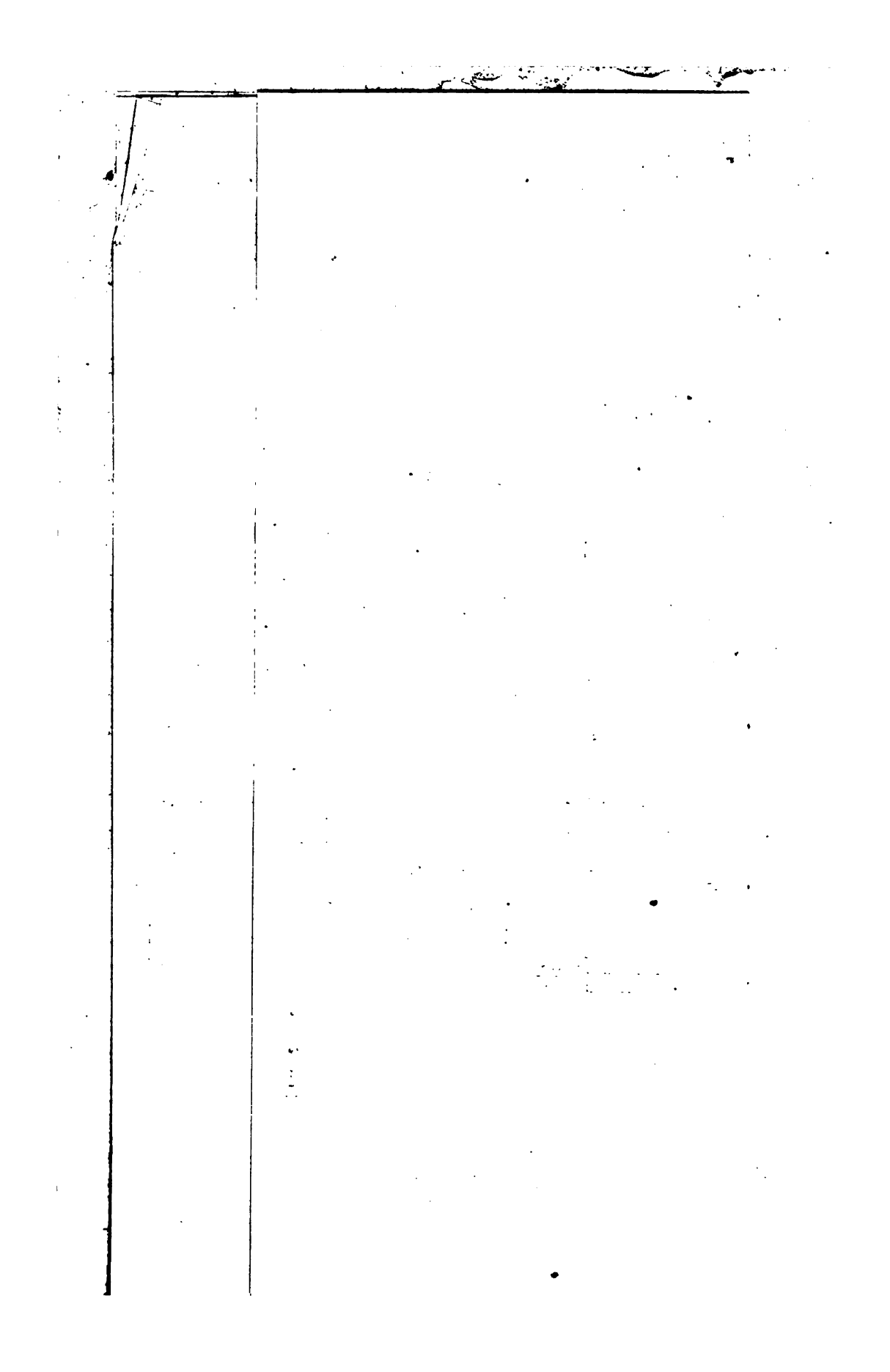
MIDDLE DIVISION.

REPORT OF HENRY T. BEACH,

DIVISION ENGINEER,

FOR THE

YEAR ENDING SEPTEMBER 30, 1889.



MIDDLE DIVISION.

Annual Report of the Division Engineer for the Fiscal Year Ending September 30, 1889.

Syracuse, N. Y., *October* 1, 1889.

Hon. John Bogart, *State Engineer and Surveyor:*

I have the honor to submit the annual report of the middle division for the fiscal year ending September 30, 1889.

	Miles.	Totals.
This division comprises that portion of the Erie canal lying between the east line of Oneida county and the south line of Wayne county	97.02	
Also the following unabandoned lateral canals:		
Oswego canal, from Syracuse to Oswego	38.00	
North and south side-cuts and slips at Salina	2.00	
Slips at Liverpool, Oswego canal	.21	
Baldwinsville side-cut	.75	
Cayuga and Seneca canal, Montezuma to Cayuga and Seneca lakes	22.77	
Black River canal, Rome to Lyons Falls	35.33	
Old Oneida Lake canal, Higginsville to first lock	1.05	
Chenango canal, from Erie canal to lock No. 1	.15	
		197.28
River Improvements.		
Black river, Lyons to Carthage	42.50	
Onondaga outlet, Onondaga lake to Seneca river	.75	
Oneida river, Three River Point to Brewerton and Oneida lake	20.00	
Seneca river towing-path, Mud lock to Baldwinsville,	5.75	
Seneca river, Baldwinsville to Jack's reefs (not used),	11.75	
Ithaca inlet, Cayuga lake to Ithaca	2.05	
Seneca lake outlet, from Cayuga and Seneca canal to Seneca lake	.26	
		83.06

NAVIGABLE FEEDERS.	Miles.	Totals.
Limestone creek feeder, Erie canal to Fayetteville	.80	
Butternut creek feeder, Erie canal to feeder dam above Dunlap's mills	2.00	
Nine-mile creek (Camillus) feeder, Erie canal to Camillus	1.00	
Delta feeder, foot of lock No. 9, Black river canal to Delta	1.38	
Black river feeder, Boonville to head of pond at Forestport	12.09	
		17.27
Total		297.61

ARTIFICIAL FEEDERS — NOT NAVIGABLE.	Miles.
Chenango canal, from lock No. 1 to lock No. 77	26.72
Leland pond feeder	.32
Madison brook feeder	3.00
West branch feeder	5.74
Bradley's brook feeder	.65
Hatch's lake feeder	.23
Kingsley brook feeder	1.93
Oriskany creek feeder	.53
Mohawk feeder at Rome	.05
Oneida creek feeder	3.04
Cowassalon creek feeder	.38
Chittenango creek feeder	.28
Cazenovia lake outlet (improved)	.49
Tioughnioga river feeder	.70
De Ruyter reservoir outlet	.12
Butternut creek (Orville) feeder	.55
Nine-mile creek (Camillus) feeder (unnavigable portion)	.65
Carpenter brook feeder	.18
Skaneateles creek feeder	.10
Putnam brook feeder	.20
Centerport feeder	.24
Owasco creek feeder (including 859 feet of iron pipe)	2.10
New outlet of third Bisby lake	.06
New outlet of Canachagala lake	.16
Total	48.42

SOURCES OF WATER SUPPLY.

The canals upon this division are supplied with water from the following-named sources:

Erie Canal — Frankfort and Rome levels.

(Three and three hundred and fifty-six thousandths miles of Frankfort level on middle division. The Rome level, lock No. 46 to lock No. 47 = 55.957 miles.)

	Cubic feet per minute.
Leland's pond, Madison brook reservoir, Eaton brook reservoir, Bradley brook reservoir, Hatch's lake, Kingsley brook reservoir and Oriskany creek, feed through the Chenango canal into Frankfort level, at Utica, and through Oriskany creek feeder into the Rome level, six miles west of lock No. 46	6,000
Mohawk river, Black river, Forestport pond, White lake reservoir, first, second and third Bisby lakes, Canachagala lake, North branch reservoir, South branch reservoir and Twin lakes, feed through the Rome feeder and Black river canal into the Rome level at Rome, fourteen miles west of lock No. 46	13,000
Oneida creek enters canal through feeder, thirty miles west of lock No. 46	1,000
Cowassalon creek enters canal through feeder, thirty-one and a half miles west of lock No. 46	200
Cazenovia Lake reservoir (for 100 days), Erieville reservoir (for 100 days), and Chittenango creek enter canal through Chittenango Creek feeder, forty-one and a half miles west of lock No. 46	5,641
DeRuyter reservoir (for 100 days), enters canal through Limestone creek (Fayetteville) feeder, fifty miles west of lock No. 46	3,891
Limestone creek (natural flow) enters canal through Limestone creek (Fayetteville) feeder, fifty miles west of lock No. 46	500
Jamesville reservoir (for sixty days) enters canal through Butternut (Orville) feeder, fifty-two miles west of lock No. 46.	2,000
Butternut creek (natural flow) enters canal through Butternut (Orville) feeder, fifty-two miles west of lock No. 46	500
Total	32,732

	Cubic feet per minute.
Short level, from lock No. 47 to No. 48=.188 of a mile; fed from Rome level.	
Mile level, from lock No. 48 to 49=.714 of a mile; fed from Rome level through short level.	
Syracuse level, from lock No. 49 to 50=5.014 miles; fed from Rome and Jordan levels.	
Jordan level, from lock No. 50 to 51=14.903 miles.	
Otisco Lake reservoir feeds through Nine-mile creek (Camillus) feeder into the canal four miles west of lock No. 50	5,146
Nine-mile creek, fed through Nine-mile creek (Camillus) feeder into canal, four miles west of lock No. 50	800
Carpenter brook enters canal through feeder, ten miles west of lock No. 50	200
Skaneateles Lake reservoir feeds into canal at Jordan, thirteen miles west of lock No. 50	8,766
Total	14,912
Port Byron level, from lock No. 51 to 52=7.793 miles from Jordan level, through lock No. 51.	
Putnam brook feeder, at Weedsport	200
Owasco lake reservoir, through feeder at Port Byron	4,033
Total	4,233
Montezuma level, from lock No. 52 to Wayne county=9.098 miles. From Port Byron level, through lock No. 52 and from Lake Erie	4,000
Oswego Canal.	
Erie canal at Syracuse	10,000
Seneca river	54,000
Oneida river	20,000
Total	84,000
Cayuga and Seneca Canal.	
Seneca lake	18,000
Erie canal at Montezuma	4,000
Total	22,000

SUMMARY OF WATER SUPPLY MEASURED.

Erie Canal.

	Cubic feet per minute. Amounts.	Totals.
Frankfort and Rome levels	32,732	
Jordan level	14,912	
Port Byron level	4,233	
		51,877
Oswego Canal.		
From Seneca river	54,000	
From Oneida river	20,000	
		74,000
Cayuga and Seneca Canal.		
From Seneca lake	18,000	
		18,000
		143,877

NOTE.—This does not include water used more than once.

BLACK RIVER CANAL AND RIVER IMPROVEMENT.

CANAL.	Elevation in feet above tide water.	Surface area in acres.	Average area in acres.	Average depth in feet.	Capacity in cubic feet.
White Lake reservoir	.....	.....	296	5	64,468,800
Chubb Lake reservoir (approximate).	1,599	.....	200	4	34,848,000
Sand Lake reservoir	.....	.....	306	15	199,940,400
Woodhull reservoir (two years in filling)	1,854	1,236	1,118	18	876,601,440
First, Second and Third Bisby lakes (approximate)	.....	.....	.....	3½	40,000,000
Canachagala lake (approximate)	.....	.....	320	4	55,756,800
North Lake reservoir (can fill twice yearly)	1,821	423	277	28	337,851,360
South Lake reservoir	2,019	518	372	26	421,312,320
Twin Lakes reservoir (approximate).	.....	.....	175	8	60,984 000
Forestport pond	.....	.....	.....	.....	.....
Mohawk river, through Delta feeder	.....	.....	.....	.....	.....
Pond above Lyon's Fall dam	.....	.....	.....	.....	.....
River Improvements.					
Forge pond	.....	.....	.....	.....	.....
First lake of the Fulton chain	1,691	.....	.....	.....	.....
Second lake of the Fulton chain	1,691	.....	.....	.....	.....
Third lake of the Fulton chain	1,691	.....	.....	.....	.....
Fourth lake of the Fulton chain	1,691	.....	.....	.....	.....
Fifth lake of the Fulton chain	1,691	9	.....	.....	.....
Sixth lake of the Fulton chain	1,772	109	.....	.....	.....
Seventh lake of the Fulton chain	1,772	867	.....	.....	.....
Eighth lake of the Fulton chain	1,776	309	.....	.....	.....
Black river	.....	.....	.....	.....	.....
Moose river	.....	.....	.....	.....	.....
Beaver River reservoir	.....	.....	.....	.....	.....

There has been no change in the water supply during the fiscal year.

NAVIGATION.

The Oswego, Cayuga and Seneca, and Black River canals, and the Erie canal west of lock No. 46, opened officially on May first; the remainder of the Erie canal on this division opened officially May fourth.

A break occurred on the Black River canal November 18, 1888, through the tow-path bank at the head of lock No. 91, making a breach about fifty feet long and extending six or eight feet below canal bottom.

It was promptly repaired and navigation resumed on November 22, 1888.

The heavy rains have occasioned some trouble on the Black River canal, both by flooding the banks and running shale and other debris into the prism, but no serious delay has occurred from this cause.

Several detentions have occurred to boats going to or coming from the west by breaks on the western division, affecting nothing, however, east of lock No. 52.

Otherwise navigation has been good and uninterrupted.

WATER SUPPLY.

The unusually wet season since the opening of navigation has given a superabundant supply of water, but the experience of former years shows that generally the water supply has been scarcely sufficient to meet all demands upon it, the heavy leakages when combined with a rather dry season, having made a large supply necessary to keep the levels up to established height. This division depends more than any other upon an artificial supply, and much care is required to keep the reservoirs so drawn that advantage can be taken of the heavy rains by storing their surplus, and also to draw the storage basins no lower than experience has shown is necessary to insure a full reservoir for the succeeding year. The Jordan, a summit level, and the Rome, a long level, also a summit level, are the most difficult to maintain at a proper height, as other levels are fed from these. Since the construction of the Otisco lake reservoir, the supply of the Jordan level has heretofore been equal to the demands of a dry season.

The improvement of the St. Mary's canal, allowing the passage of vessels drawing some six feet more water than the Welland canal must induce larger shipments to Buffalo, and renders it extremely probable that there will be a large increase of traffic on the Erie canal in the near future, which may overtax the present sources of supply to this level.

There is a large area of unutilized water-shed south of the Jordan level which could be made available, in case of necessity, by reservoir dams, which would also impound a portion of the spring flood water now lost to the canal.

A considerable quantity of water is fed through lock No. 51 to supply the deficiency on the Port Byron level, caused by the inadequacy of the Owasco feeder. The latter consists of an iron pipe at the canal end, having a capacity of 6,000 cubic feet per minute, and an open channel, supplying the pipe, which has a capacity of only 4,000 cubic feet per minute, and frequently, owing to obstructions from eel-grass, etc., only actually delivers about 2,000 cubic feet per minute. If this channel were enlarged to the full capacity of the pipe it would, with the lockage and leakage from lock No. 51, fully supply the present needs of the Port Byron level, thus reducing the demand for the Jordan level.

A better plan, however, in my opinion, is to make a new open feeder to the canal from the first dam south of the same.

It would be less expensive; would lie at the level of canal instead of fifteen feet above it; would avoid the high, dangerous banks of the present feeder; would be only about one-fifth as long; would give a storage pond of about thirty acres, about three-eighths of a mile from the canal; be more accessible and more permanent, requiring less care and less expense for repairs.

I would recommend the construction of this open feeder at an early day with a head-gate capacity of 8,000 cubic feet per minute — the total flow of the stream in dry seasons — to provide for future emergencies. The additional cost of the increase of capacity would be a mere trifle.

Another unnecessary demand — so far as canal interests are concerned — upon the Jordan level is at the Amos spillway on the Syracuse level. The owners of the Amos mills have acquired a right to the surplus waters of the canal at this point under a lease, which I understand can be abrogated at any time by the Superintendent of Public Works. Under authority of the Canal Board the crest of the spillway, over which this surplus water passes to their flume, is placed three inches below the standard surface of the canal, thus enabling them to draw three inches in depth over a weir 100 feet long, whether there is a surplus or not. Observations and calculations indicate that there is no surplus in the dry season and that the deficit, occasioned by this and legitimate causes, is supplied by special feeding from the Rome and Jordan levels. I recommend that this spillway be placed and maintained at standard height.

Under present conditions the Rome level is insufficiently supplied in a dry season.

The new Forestport reservoir now under contract will materially relieve the difficulty, as it will afford a considerable additional storage, and being nearer the line of canal and within the limits of quick communication, its waters can be more economically as well as more effectively used.

The Oriskany feeder from the State dam to the canal has been enlarged and improved during this fiscal year, giving a more free and quicker delivery in case of necessity. The upper portion of this system, however, remains as before, and I renew the suggestion of last year, to improve the feeder leading from Kingsley Brook reservoir, as affording considerable relief to the Rome level at a very slight expense.

I also renew the recommendations of last year to extend the pipes of the Kingsley Brook reservoir, according to the original plan; to protect the foot of Jamesville dam from danger of undermining, and the pointing and repairing of all masonry structures needing the same.

The great disaster which occurred at Johnstown, Pa., on May 31, 1889, illustrates at a terrible cost the necessity for a ceaseless vigilance and prompt action in the care of these structures, that the first manifestation of weakness or danger may be discovered, and its cause removed. Fortunately, all our reservoir dams are well built and need only proper care and attention to preserve them indefinitely in perfect safety. The reservoir dams on this division have been carefully inspected, and such repairs made as were found necessary.

The recommendation to increase the size of valves in the gates of Oswego canal guard locks, or provide supplemental feed valves, is also renewed. The valves are of the usual size, four by two and one-half feet, and the head is frequently reduced to a few inches, when it becomes impossible to maintain the level below at proper height. The guard locks, being three feet wider than the standard lift locks, will admit an additional length of nine inches to each valve. As these locks are never under an extremely large head, the width of valve might be safely increased to three and one-half feet. These dimensions would add seventy-five per cent to their discharging capacity, compared with present size.

MACHINERY FOR DRAWING BOATS INTO LOCKS.

This device continues to work successfully, and has been applied to lock No. 11, on the Oswego canal. It is also intended to place it on locks Nos. 9 and 10, now under contract to be lengthened. It has

proved of great value in decreasing the time of lockage, and should be placed on all lengthened lift locks.

IMPROVEMENT OF CHANNEL.

Much has been done to restore the prism of the canal to the original depth, with very beneficial results. Much more remains to be done especially on the Oswego canal, where the condition is much worse than on the Erie.

On nearly all the "canal" levels proper, the bottom as well as the sides is filled to a depth of six inches or a foot, rendering it necessary to carry the water surface higher to that extent than was originally intended, in order to pass loaded boats. The remarks on this subject in last year's report are still fully applicable.

The harbor below lock No. 18, being on the level of Lake Ontario, is subject to the fluctuations in water surface of that body. It has become filled with sediment and rubbish until, at ordinary low water, loaded boats can not go outside the main channel and can only pass with difficulty in the deepest portions. It should be dredged so as to make the whole area available for loaded boats at extreme low water.

On the Black River canal the principal difficulty arises from the deposit of fine shale in the prism by every freshet, sometimes to such an extent as to temporarily prevent the passage of boats. This can be remedied and perhaps entirely prevented by building receiver dams, the basins thus formed being cleaned out when necessary. These dams can be very cheaply constructed of brush and stone, as there is no necessity for making them water tight.

STRUCTURES.

The structures are generally in very good condition. The bridges, particularly, have been kept in good repair. Many of them, however, need painting. In renewing the wood-work of the floors of iron bridges, the cleaning and painting of the iron-work is apt to be neglected at the only time when it can be thoroughly done. The difficulty of obtaining good bridge-timber now and the small difference in cost between wooden and iron bridges should prevent the reërection of wooden superstructures on the canal as a matter of economy. It is difficult to tell just when a wooden bridge is actually unsafe, some structures lasting much longer than others. I would recommend that some general plans of iron bridges be adopted, as repairs to the wood-work will be more cheaply made if the floor system is uniform; and the iron-work, also, can be repaired at less expense.

I would renew my suggestion in last year's report regarding the classification of bridges and the adoption of a standard plan for each class.

West street lift-bridge still works very slowly, evidently from lack of power. I would recommend replacing the hydraulic cylinder by a turbine, discharging into Onondaga creek.

The lift-bridge does not seem to meet the requirements for a low bridge. Doubtless most of the minor objections can be removed by changes in detail of construction, but the chief objection, in my mind, can not be obviated; that is, its lateral rigidity, which makes it certain that if the bridge — either from misjudgment of time or lack of attention on the part of the bridge-tender, or from any other cause, is not fully raised, serious damages must result to bridge, boat, or both. I would suggest in their stead swing-bridges, carrying simply the driveways; no sidewalks, but fixed overhead foot-bridges for the use of foot passengers, the bridge to rest on a pier composed of iron piles, placed in the center of the canal where the prism is of standard width or more, and the bridge made "double-ended" in all cases where practicable. This style of construction reduces the obstruction of waterway and weight of bridge to a minimum, and avoids the difficulty experienced in properly balancing a "single-end" bridge under the constantly varying conditions of wet and dry weather, new and old flooring, clean or dirty roadways.

Swing-bridges can be cleared quicker than lift-bridges, in case of impending collision, and if struck, either while at rest or in process of opening, greatly reduce the effect of a blow by yielding sidewise.

WALLS AND BANKS.

Considerable has been done during the fiscal year to repair the damage done to the banks by swells from fast steamers, and protect them from future injury; but the reduction of force rendered necessary by the so-called two-dollar-a-day law, prevented as much being done as would have been under other conditions. The remarks contained in last year's report on this subject are therefore still applicable, and the good work should go on.

A small appropriation was made last winter for constructing or reopening the drainage-ditches along the foot of slopes to prevent damages and claims therefor, which have heretofore proved so expensive to the State. This appropriation, being insufficient for the entire work of this character, has been expended only where the liability of the State has been established by awards of damages, and only in the most important of these cases. An appropriation should be made next year, and annually thereafter, sufficient to construct and keep open these ditches in all places where, in the judgment of the State Engineer and Surveyor and the Superintendent of Public Works, they are necessary.

Serious trouble frequently arises from the unsanitary condition of the old canal, which, in most cases on this division, forms stagnant pools. A sufficient appropriation should be made to provide ample outlet and drainage of these ponds, and authority given for the proper maintenance of the necessary ditches or other means of securing this result.

RECORD OF BRIDGES AND LEVELS.

The bridge record on the Erie, made in 1878, has become misleading, as changes have not been recorded. I have caused a partial survey of this nature to be made on the Erie, Oswego and Cayuga and Seneca and Black River canals, giving the principal ground-plan dimensions of bridges, the result of which will be found in the table annexed. I was unable, from lack of means and force, to make the thorough detail survey and inspection which, in my opinion, should be made.

The former detail record, though very valuable when made, is now misleading and therefore worse than useless. I would recommend that provision be made for this survey during the next summer, to include all the State bridges, including those not on the line of canals. Bridges should also be permanently renumbered.

I have had the defective levels on the Erie canal tested and corrected, and append a table of corrected elevations of the bench-marks. The bench-marks on the Erie canal have never been permanently marked. I recommend that they be so marked, and also recommend the extension of the levels and bench-marks to all the canals of the division.

SPECIAL SURVEYS.

The location of the "blue line" is very indefinite, especially in cities where it is of most importance on account of the greater value of land and consequent greater temptation to encroachment. I would recommend the reëstablishment of the "blue line," particularly through the cities and villages, and its definite location by references to permanent structures, so that it may be readily and accurately retraced at any time.

The capacity of reservoirs and feeders is largely estimated. I would suggest an accurate determination of the matter as soon as practicable.

The flow-line of Beaver River reservoir should also be completed. It is now only about half done.

For all these surveys special provision of funds and force will have to be made.

APPROPRIATIONS OF 1887 — ERIE CANAL.

Chapter 113.

Berme lock No. 46, to be lengthened at the foot, was let June 28, 1887. Some material was delivered and a little excavation done, when work was stopped by injunction and subsequently suspended indefinitely by the Superintendent of Public Works. It has been decided to continue the work by lengthening at the head, but nothing has been done since January 1, 1888.

OSWEGO CANAL.

Chapter 351.

State ditch at Liverpool. Nothing has been done.

DREDGING OUTLET OF CROOKED LAKE.

Chapter 234.

The work was completed previous to October 1, 1888. Final rendered this year.

APPROPRIATIONS OF 1888 — ERIE CANAL.

Chapter 371.

Draining the old Erie canal in the city of Rome. This work was let July 3, 1888. The greater part of the sewer pipe was delivered, and a small amount of excavation done, when work was stopped by an injunction which has not been dissolved, consequently no further work has been done.

Chapter 372.

Wall between South James street and the Black River canal along the north blue line of the Erie canal.

This work was let July 3, 1888, has been completed in a very satisfactory manner, and final rendered.

Chapter 416.

Bottoming the Erie canal. This act was amended by chapter 110, Laws of 1889, permitting to Superintendent of Public Works to do this work by "contract or otherwise." Under this provision as large a force was employed as practicable, and as much work done as possible before the opening of navigation.

Dredges have also been employed during the season at points where they could work to advantage. In this manner the worst portions of the canal have been restored to the original depth. The work should be continued until the whole canal is thus restored.

Chapter 417.

Erection of a swing or lift bridge at Schuyler street, Utica. Survey, estimates and plans are made, but the work not let.

OSWEGO CANAL.

Chapter 416.

Lengthening two or more locks and bottoming out the canal.

Guard lock No. 3, at Oswego Falls (Fulton), and lock No. 11 (Orchard lock), about one and one-half miles below Fulton, were selected for lengthening, as giving the greatest benefit in connection with previous work of this character. The work was let August 8, 1888.

Machinery to facilitate hauling boats into the lengthened lock No. 11, was let August 8, 1888.

All this work has been completed in a satisfactory manner, and finals rendered.

The estimated cost of the lengthening of these two locks precluded any attempt at bottoming out.

CAYUGA AND SENECA CANAL.

Chapter 325.

Excavating channel of Seneca river and the old Bear race, in the village of Waterloo.

This work was let December 14, 1888. About one-half the excavation of old Bear race was done when the work was stopped by injunction February 11, 1889. The injunction has not been dissolved, therefore, no work has been done on construction since the latter date.

Chapter 416.

The general improvement of the canal.

Under this act the rebuilding of lock No. 8 and repairing piers at Geneva and Ithaca, and piling at Geneva were selected. Lock No. 8 was not let, no bids being offered, owing to the late date of letting.

The piers and piling were let January 8, 1889, have been satisfactorily completed and finals rendered.

BLACK RIVER CANAL.

Chapter 270.

Substituting vertical wall in place of slope wall between the Black River canal and Lock street in the city of Rome.

This is an extension of the vertical wall built under chapter 550, Laws of 1886.

The work was let July 3, 1888, has been completed in a very satisfactory manner, and final rendered.

Chapter 416.

Improvement of the Black River canal.

Under this act it was decided to rebuild lock No. 60, about four miles south of Boonville.

This lock is the upper of three combined. The lower and middle locks of the combination are founded on solid rock, but the foundation of lock No. 60 was from two to seven feet above the rock. The space between the rock and bottom of foundation was originally filled with the local light shale, which disintegrated and washed out, undermining the foundation, causing it and the lock walls to settle. On taking up the foundation and cleaning the rock beneath, several large fissures and sink-holes were found. These were carefully plugged with stone and concrete, and a rubble retaining wall built directly under the lock wall at head and sides, reaching from the solid rock to the bottom of foundation. The space thus inclosed was filled to a height of one foot below the bottom of foundation timbers, with selected material thoroughly compacted. Over this the foundation proper was laid, consisting of timbers one foot in depth with concrete beneath and between them and the usual planking over them, upon which the lock-walls were built. The work has been satisfactorily completed and final rendered.

CHEMUNG CANAL.

Chapter 416.

Constructing a basin at Havana and reopening the Seneca lake level.

The bids at the first letting being above the appropriation, a new estimate was made including only the swing-bridge at Watkins over the lake level. This portion of the work was let March 13, 1889, and is now in progress,

The unprecedented high stage of water during the summer has embarrassed the contractors and seriously delayed the work, but it is now progressing favorably.

The superstructure is ready for erection and partly delivered.

The remaining portion of this work (basin at Havana and dredging the lake level), after a further appropriation was secured, was let September 3, 1889, but no work has been done except in preparation.

MISCELLANEOUS.

Chapter 206.

Crooked lake.—Improving outlet and removing portion of bar at Branchport. Contract was made May 25, 1888, and the work completed satisfactorily previous to October 1, 1888. Final has since been rendered.

Chapter 192.

Canandaigua lake.—Deepening harbor and constructing breakwater at the foot of the lake. Let August 27, 1888. The work has been satisfactorily completed, but the final not yet rendered.

Chapter 291.

Swing-bridge across Cayuga inlet at Buffalo street, Ithaca.—Let March 7, 1889. The work has been completed and finals rendered This bridge is supported at the ends upon wooden abutments, consisting of three rows of piles, capped and tied together by cross-timbers, notched and drift-bolted to the caps.

When first completed the bridge worked freely and appeared to be all right. When the filling of the approaches was completed it was discovered that the material into which the piles were driven did not afford them sufficient lateral support to counteract the pressure of the filling behind the abutments. The latter were forced in, holding the bridge as in a vice, so that it could not be moved. Anchor-piles have been driven in each approach about twenty-five feet back from the abutments and iron rods run from a timber back of these piles to the rear cap of the abutment piles and drawn tight with nuts and screws, bringing the abutments back into position and holding them there. The track which was somewhat distorted is now being adjusted.

Chapter 132.

Dredging Cayuga inlet, done by the Superintendent of Public Works.

Chapter 367.

Removing obstructions from the Oswego river below the village of Phœnix. The work has been let but nothing done toward construction.

Chapter 270.

Repairing road from Forestport to Woodhull. Appropriation has been nearly exhausted under direction of the Superintendent of Public Works.

Chapter 249.

Surveys for board of claims.

About $2,000 has been expended for surveys, maps, etc., under this act.

Chapter 270.

Repairing roads and bridges and removing obstructions in Onondaga creek, on the Onondaga Indian Reservation.

Five hundred and forty-nine dollars and five cents has been expended on this work, by the Superintendent of Public Works.

APPROPRIATIONS OF 1889.— ERIE CANAL.

Chapter 213.

Rebuilding vertical wall at Kellogg's lumber yard, in Utica. Let September 24, 1889. No work done on construction.

Chapter 557.

Bridge at George street, Rome.

Plans and estimates were made and the work twice advertised for letting, but not awarded, as the bids exceeded the appropriation.

Chapter 568.

Deepening the canal to standard depth. Nothing done.

Chapter 570.

Raising and widening abutments of West Genesee street bridge, Syracuse. Nothing done.

Bridge over State ditch at Manlius Center. Has been built under direction of the Superintendent of Public Works.

Chapter 570.

Under this act an engineer was detailed to accompany the engineers of the Syracuse water commission on their survey of the watershed, etc., south of the Jordan level, to observe the methods and character of survey, and report the same to the division engineer.

It was found that proper methods were used and an accurate survey made.

OSWEGO CANAL.

Chapter 151.

Repairing State dam at Baldwinsville. Nothing done.

Chapter 241.

Rebuilding canal wall and culvert at Oswego. Let August 30, 1889. Progressing favorably.

Chapter 568.

Lengthening two or more locks on the Oswego canal, and machinery for hauling boats into the locks.

Locks Nos. 9 and 10, in the village of Fulton, were selected as best supplementing previous work of this character. They were let July 30, 1889, and a large amount of material has been delivered. Bids were received for machinery September 27, 1889, but the contract is not yet made.

Chapter 568.

Deepening the channel of the canal to standard depth. Nothing done.

ONEIDA RIVER IMPROVEMENT.

Chapter 568.

Deepening, by raising dams and dredging. Nothing done except preliminary survey.

CAYUGA AND SENECA CANAL.

Chapter 150.

Repairing second level and State ditch at Seneca Falls. Preliminary survey made.

Chapter 568.

General improvement. Under this act the rebuilding of lock No. 8 was let September 27, 1889, but no work has been done on construction.

BLACK RIVER CANAL.

Chapter 274.

Reservoir, above Forestport pond.

The dam and its necessary embankments, bulkheads, etc., was let August 30, 1889.

Some material has been delivered.

Chapter 568.

General improvement. Rebuilding lock No. 12, was selected under this act.

It was let July 30, 1889. The stone and some other materials have been delivered.

CHEMUNG CANAL.

Chapter 570.

Surveys for Board of Claims.

Under this act the salary and expenses of the engineer in charge of surveys for claims at Horseheads, for attendance at trials, was paid.

MISCELLANEOUS.

Chapter 155.

Repairing State embankment at Sherburne (Mad Brook). Plans and estimate have been made, the work advertised, but not let, as the bids exceeded the appropriation.

Chapter 204.

Improving harbor at the foot of Canandaigua lake. Let August 30, 1889.

The piling for breakwater and repairing pier is nearly completed.

The following are placed solely in charge of the Superintendent of Public Works:

Chapter 80.

Iron pipe sewer under the Erie Canal at Utica.

This is a four foot cast-iron pipe lying at a depth of about eighteen feet below canal bottom, and situated a short distance west of Nail creek culvert. It was successfully laid immediately before the opening of navigation, and has given no trouble since. The work was done by the city of Utica, under contract, and under the supervison of the Superintendent of Public Works.

Chapter 166.

Fishway on dam across Chittenango creek near Bridgeport. Nothing done.

Chapter 240.

Ditches to carry off leakage from the canals.

The appropriation has been judiciously expended by the Superintendent of Public Works.

Chapter 436.

Repairing highway near Castorland. Nothing done.

Chapter 570.

Repairing road crossings on the abandoned Oneida Lake canal. Nothing done.

On the Erie canal, the Syracuse Steam-Heat and Power Company have laid a steam-pipe under the canal, about midway between Salina and Clinton streets, Syracuse. They also cross the canal on an overhead bridge at the east end of the weigh-lock at Syracuse.

This was done by the company under permit from the Superintendent of Public Works.

An iron bridge was constructed over the Crooked lake outlet at Liberty street, Penn Yan; the State contributing $2,000 from the fund for improving the outlet. The towns concerned furnishing the remainder of the funds and superintending the work.

ORDINARY REPAIRS MADE DURING THE FISCAL YEAR — ERIE CANAL.

Aqueducts.

Jordan.—Some floor timbers renewed.

Centerport.— Replanked and two floor timbers renewed.

Crane Brook.— Replanked.

Seneca River.— Four spans rewooded.

Bridges.

The following superstructures have been rebuilt.

No. 20. Yorkville road, abutments raised and Bollman truss replaced by a riveted wrought-iron truss, by the Rochester Bridge and Iron Works, under the direction of the Superintendent of Public Works. Farm bridge over Oriskany feeder.

No. 40. Jay street, Rome, berme abutment set back and rebuilt, wings of tow-path abutments raised, and the superstructure replaced by the Bollman truss from Yorkville road (No. 20). Tow-path bridge over Wood creek. Chittenango, feeder-bridge, new abutments and superstructure.

No. 109. Gere's landing, road bridge.

The following bridges have been repaired.

No. 1. Green's road, Utica, replanked.

No. 4. Broad street, Utica, rewooded and thoroughly repaired,

No. 12. Broadway, foot Utica, general repairs.

No. 22. Westmoreland street, Whitesboro, new guard rails on both approaches. Road bridge over Oriskany feeder, replanked.

No. 31. Kirley's farm, new needlebeams. Tubular tow-path bridge over Black river canal, replanked.

No. 37. James street, Rome, roadways replanked and general repairs.

No. 38. Washington street, Rome, east roadway replanked.

No. 39. George street, Rome, east roadway replanked.

No. 42. Doxtator avenue, Rome, painted.

No. 43. Barnes road, painted

No. 45. Armstrong's farm, replanked.

No. 48. Tuttle's road, replanked.

No. 49. Main street, New London, replanked.

No. 51. Grove Spring road, three new bents under bridge.

No. 60. Durkee's road, painted.

No. 75. Chittenango road, replanked.

No. 81. Kirkville road, replanked.

No. 91. William street, Syracuse, sidewalks rewooded.

No. 93. Orange street, Syracuse, replanked and some new joists.

No. 98. Warren street, Syracuse, rewooded entire.

No. 100. Salina street, swing, Syracuse, new axles, wheels, joist and plank.

No. 101. Clinton street, Syracuse, replanked.

No. 102. Franklin street, foot, Syracuse, rewooded.

No. 103. West street, lift, Syracuse, replanked and new cylinder.

No. 104. Geddes street, Syracuse, rewooded.

No. 108. Blast furnace road, Geddes, replanked.

No. 110. Gere's farm, rewooded.

No. 111. Belle Isle road, replanked.

No. 112. Amboy road, replanked.

Bridge over Camillus feeder, replanked.

No. 113. Camillus road, replanked.

No. 114. Newport road, replanked.

No. 115. Memphis road, replanked.

No. 119. Beaver, street, Jordan, painted.

No. 128. Seneca street, Weedsport, replanked.

No. 137. Canal street, Port Byron, general repairs.

No. 139. McLeod's road, general repairs.

No. 141. Salt street, Montezuma, general repairs.

No. 142. High street, foot, Montezuma, general repairs.

No. 143. Change at junction with Cayuga and Seneca canal, general repairs.

No. 144. Clark street, Montezuma, replanked.

No. 145. May's point road and change, general repairs.

Culverts.

Composite culvert west of New Boston bridge was cleaned out.

North wings Harbor Brook culvert at Syracuse, were taken down and relaid.

Box culvert at Weedsport, cleaned out.

Docking.

One thousand four hundred lineal feet put in on section 7.

Feeders.

Oriskany, cleaned out and widened.

Chittenango, cleaned out.

Gilley's Brook feeder, between Newport and Memphis bridges, cleaned out.

Jordan feeder, repaired.

Port Byron feeder, banks strengthened.

Locks.

Lock No. 46.— Masonry in Wells taken up and replaced.

Lock No. 47.— Part of foundation concreted and two new balance beams put on.

No. 49. Five new balance beams; two new valves and bucking beams inserted. West pier repaired.

Syracuse weigh lock, half of chamber replanked.

No. 50. Masonry repointed, five new valves and two bucking beams inserted, and two gates replanked.

No. 51. Two new balance beams.

No. 52. New foot bridge at west end of berme lock and general repairs.

Spillways.

At Amos' mill, Syracuse, about thirty feet rebuilt.

Waste-weirs.

Ballou creek, Utica, masonry repaired.

One west of Murphy's road bridge (No. 32), apron taken up, grouted nd replanked.

Durhamville waste-weir bridge rebuilt.

Putnam brook channel cleaned out.

Walls.

Tow-path wall, under Tuttle's bridge (No. 48), rebuilt.

Tow-path wall, west end of Jordan aqueduct, thirty-five feet rebuilt

One hundred lineal feet, west of bridge No. 131, built new.

Five hundred feet of slope wall on section No. 7 was raised to full height.

ORDINARY REPAIRS MADE DURING THE FISCAL YEAR — OSWEGO CANAL.

Bridges.

No. 7½. Park street, over south side cut, was replanked.

No. 9. Green Point road and change, one roadway was replanked.

No. 10. Liverpool road, one side was replanked.

No. 11½. Outlet bridge was replanked.

No. 12. Cold Spring, was replanked.

No. 21. Broadway, at Fulton, sidewalks were replanked.

No. 23. Oneida street, Fulton, was rewooded.

Leonard street, Fulton, was replanked.

No. 25. Road and change, was replanked.

Locks.

Lock No. 1.— One tow-path gate was replaced.

Lock No. 2.— Two new upper gates were put in.

Lock No. 3.— One new gate was put in.

Guard Lock No. 1.— New upper gates put in.

Lock No. 10.— New lower gates put in.

Lock No. 13.— New lower gates put in.

Lock No. 14.— Two new balance beams put in.

Lock No. 17.— One new balance beam put in.

Lock No. 18.— New upper gates put in.

Sluices.

No. 2. Tow-path side was rebuilt.

Eight sluices have been repaired.

Spillway

at Salina was rebuilt.

River wall

on berme side at Oswego was rebuilt and repaired where necessary.

The division wall at Penfield and Lyons mill site was rebuilt in a substantial manner.

ORDINARY REPAIRS MADE DURING THE FISCAL YEAR — CAYUGA AND SENECA CANAL.

Bridges.

Lake street, Geneva, was repaired.
Evans street, Geneva, was repaired.
Tow-path bridge, over Soap Mine, was repaired.
Teal's road, was repaired.
Lake bridge, over outlet, was replanked.
On short level, Waterloo, was repaired.
Tow-path, over Silver creek, was repaired.
Kingdom road, has had some new plank.
Tow-path, over Sackett's brook, was repaired.
Bridge street, Seneca Falls, was repaired.
Ovid street, Seneca Falls, was replanked.

Dams.

Distillery, new flush boards put on.
Demont's, was repaired.
Burns', was repaired.

Docking.

Docking replaced, berme side Virginia street bridge.
Docking replaced near Gorham bridge.
Docking repaired between locks Nos. 3 and 4.
Docking replaced between locks Nos. 5 and 6.
Docking replaced on tow-path and berme-side, lock No. 8.
Docking replaced above and below lock No. 10.

Locks.

Lock No. 1.— Was repaired.
Lock No. 2.— Two new lower gates were put in.
Lock No. 7.— Was repaired. Is now in good order.
Lock No. 8.— New balance beams were inserted.
Lock No. 9.— Two new balance beams were inserted.

Piers.

At foot of inlet were repaired.
At Geneva, was repaired.
At Cayuga, some new piles were driven at east end.

Receivers.

Castle creek has been dredged.

Piles.

Piles were driven along canal between Lake street bridge and Evans street, Geneva.

Forty piles with fenders were driven at Big Bend.

Towing-path.

The towing-path on this canal has been repaired where necessary.

BLACK RIVER CANAL.

Aqueducts.

No 1. Over Mohawk river, above lock No. 8. Roadway (tow-path) is being rebuilt.

No 5. Sugar river. Trunks of two spans rebuilt.

Bridges.

Lee, Pitcher and S. Jones bridges, abutments built.

Phelp's farm, general repairs.

No. 44. Road bridge, near Sugar river aqueduct, general repairs.

No. 47. Farm bridge north of lock No. 91, replanked.

No. 48. Second farm bridge, north of lock No. 91, general repairs.

No. 49. Third farm bridge, north of lock No. 91, general repairs.

No. 50. Farm bridge, north of lock No. 92, general repairs.

No. 53. Farm bridge, north of lock No. 94, bent on tow-path rebuilt.

No. 54. Second farm bridge, north of lock No. 94, general repairs.

No. 55. Main street, Port Leyden, rewooded entire.

No. 59. Farm bridge, north of lock No. 101, general repairs.

No. 61. Road bridge at Lyon's Falls, general repairs.

Bridge over Black river, at junction with Moose river, rewooded entire.

Bridge over Moose river, general repairs.

Beach's bridge, over Black river, replanked.

Culverts.

Halls' walls partially relaid twice, outlet cleaned out.

Docking.

One hundred feet built on west side of junction at Rome; sixty-four feet at foot of lock No. 64, and where needed at the head of several other locks.

Locks.

Lock No. 1.—Lower wings dressed off on account of settling.

Lock No. 3.—Lock-house is being rebuilt.

Locks Nos. 7, 30, 34 and 82.—New miter-sills inserted.

Locks Nos. 4, 9, 15, 20, 26, 33, 34, 35, 58, 59, 63, 75, 77, 95, 98, 106, 108 have each had one new gate.

Locks Nos. 3, 24, 29, 56, 70, 71, 73, 78, 87, 103 have had two new gates each.

Locks Nos. 38 and 57 have had three new gates each.

Lock No. 60 has had four new gates.

Sluices had been rebuilt at Lock No. 85 and those at the other locks repaired where necessary. Lock-houses have received general repairs.

Waste-weir.

Near Lock No. 70.— Spillway and bridge rebuilt.

REPAIRS NEEDED — ERIE CANAL.

Aqueducts.

Saquoit needs new sides.

Cowassalon.— New sides and outside floor timbers, and fifty oak piles for rack south of culvert.

Limestone.— New sides, floor plank and lining.

Butternut.— New sides, floor plank and lining.

Jordan.—New floor entire.

Centerport.— Cleaning out west side.

Seneca river.—Two spans need rewooding.

Bridges.

No. 27. Christmann's farm, needs rebuilding.

No. 34½. On berme, east of Utica, needs rebuilding.

No. 51. Grove Spring road, needs rebuilding.

No. 55. Happy Valley road, needs rebuilding.

No. 70. Beebe's road, needs rebuilding.

No. 71. Herrick's farm, needs rebuilding.

No. 82. Manlius Center (provided for), needs rebuilding.

No. 123. Fountainville road, needs rebuilding.

No. 124. Field's road, needs rebuilding.

No. 7. John street, Utica, needs replanking.

No. 8. Genesee street, Utica, needs replanking.

No. 9. Hotel street (lift), Utica, needs replanking.

No. 14. Whitesboro street, Utica, needs replanking.

No. 19. Whitesboro road, needs replanking.

No. 22. Westmoreland street, Whitesboro, needs replanking.

No. 28. River street, Oriskany, needs replanking.

No. 64. Main street, Durhamville, needs replanking.

No. 65. Bennett's road, Durhamville, needs replanking.

No. 96. East tow-path bridge over Oswego canal junction, needs replanking.

No. 57. Change north of lock No. 81, new chords. Whittlesey's bridge, over black river, swing portion should be rebuilt of iron.

Glendale bridge, new coping under track of swing.

Illingsworth's bridge, upper portion of center pier rebuilt.

Culverts.

No. 2. Above lock No. 30 is too small, should be rebuilt and outlet for 800 feet below it widened.

No. 3. Above lock No. 37, channel above should be cleaned.

Dams and feeders.

Lansingkill. Piling needed and current changed to opposite side.

Dam at Lyons Falls. Flush boards should be made permanent.

Dam at Old Forge. New gates and thorough general repairs.

Locks.

Lock No. 1. Lower wings and all hollow quoins rebuilt; stone are good.

Lock No. 18. Should be rebuilt next year; is very bad.

Lock No. 37. Should be rebuilt.

Lock No. 40. Walls need thorough repairs.

Lock No. 55. Must be rebuilt; walls had to be chipped this season to pass boats.

Lock at Forestport. New gates and eight valves.

Lock No. 76. Has settled badly; must be rebuilt.

Lock No. 89. Large hole in bottom; must be repaired.

Otter Creek lock. Rebuilt from water surface.

Bush's lock. Embankment in north side of abutment to dam needs extensive repairs.

Fifteen new miter-sills are needed on section No. 2.

New planking and docking is needed at all the locks, except those lately rebuilt (Nos. 8, 48 and 60).

Ten new lock-houses are needed.

Prism.

Nearly the whole canal needs bottoming out and receivers built in streams emptying into the canal, as recommended in general report.

Reservoirs.

House at North lake should be rebuilt.

Gates at Twin lakes must be repaired, and the upper timbers renewed.

Waste-weirs.

No. 2. Forestport feeder, walls taken up and relaid.